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disruption of testing regimes. A central conclusion from this study is that shorter development cycle times favorably correlate with lower levels of these sources of program instability, and with substantially better project outcomes.

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Alan S. Gilbreth and Sylvester Hubbard

Incentive and award fees are not driving performance outcomes as originally envisioned. In 2005, the Government Accountability Office (GAO) identified an apparent disconnect between the use of certain measures like incentive and award fees and expected outcomes in major acquisitions (GAO, 2005). In response to the GAO report, the authors conducted a research effort to better understand where incentive and award fees had favorable impact on performance outcomes and why. This article summarizes the findings of the research, highlights several organizations that clearly used techniques that drove favorable outcomes, and provides recommendations and take-aways that will promote effective and efficient incentive and award fee programs.

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COL Christopher R. Paparone, USA (Ret.)

The author applies social construction theory to reveal potential blind spots associated with the technical rationality paradigm rooted in the Defense Department's Planning, Programming, Budgeting and Execution (PPBE) process. Drawing heavily on Karl E. Weick's (1995) version of sensemaking (i.e., using, modifying, rejecting, and creating new paradigms or shared mental models when dealing with situations of incoherency and disorderliness), this article reveals the paradoxical qualities along three socially constructed schemes: the Pentagon world of PPBE, the world of political reasoning, and the hyperturbulent world described as our contemporary operating environment (COE). Ultimately, the author argues that Defense resource management professionals could be living in a dream world not unlike that imagined by the character, Neo, in the popular movie, *The Matrix*©.

DEFENSE ARJ EXECUTIVE EDITOR

Welcome to the *Defense Acquisition Review Journal* (ARJ) Issue 48. The first article in this issue, "Does Organizational Level Influence Self-leadership in the Defense Acquisition Workforce?" by Trudy C. DiLiello and Jeffery D. Houghton deals with leadership and creativity in the defense acquisition workforce, and summarizes the findings of their research. The authors conducted a study investigating the relationships between self-leadership and creativity in the context of a defense acquisition organization. More specifically, this study examined differences in self-leadership, creativity, and perceived organizational support for creativity between line- and supervisory-level defense acquisition employees.

The following article, "Lessons from the Development of Army Systems," by Richard G. "Dick" Rhoades and William A. "Bill" Lucas investigates the impact of program stability on program outcomes. Uncertainty of a project's future and funding cutbacks were found to have a strong predictive influence on development program effectiveness. A central conclusion from this study is that shorter development cycle times favorably correlate with lower levels of these sources of program instability, and with substantially better project outcomes.

In the third article, "How to Make Incentive and Award Fees Work," by Alan S. Gilbreth and Sylvester Hubbard, the authors conducted a research effort to better understand where incentive and award fees had favorable impact on performance outcomes and why. This article summarizes the findings of the research, highlights several organizations that clearly used techniques that drove favorable outcomes, and provides recommendations and take-aways that will promote effective and efficient incentive and award fee programs.

In the next article, "PPBE: A Red or Blue Pill? Can Defense Sensemakers Really be Rational in a Hyperturbulent World?" by COL Christopher R. Paparone, USA (Ret.), the author applies social construction theory to reveal potential blind spots associated with the technical rationality paradigm rooted in the Defense Department's Planning, Programming, Budgeting and Execution (PPBE) process. This article expands upon Karl E. Weick's version of sensemaking (i.e., using, modifying, rejecting, and creating

new paradigms or shared mental models when dealing with situations of incoherency and disorderliness) to examine the effectiveness of PPBE in a turbulent world.

In the fifth article, "System of Systems Development for the DoD: Tailoring Acquisition Reform for Emerging Needs," CDR Scott Moran, USN, discusses the challenges of developing Systems of Systems. When the Defense Acquisition Performance Assessment (DAPA) panel proposed sweeping reforms to address long-standing problems in defense acquisition, their recommendations did not anticipate critical challenges expected in the development of an SoS. Defense leaders counting on revolutionary SoS capabilities must appreciate that current and proposed acquisition systems insufficiently facilitate SoS development. This article describes the importance of adapting defense acquisition processes to enable effective SoS development and concludes with proposed modifications to the DAPA Report recommendations. Tailoring defense acquisition organization, budgeting, and requirements generation systems to overcome the challenges of SoS acquisition will be essential for tomorrow's military systems to realize their potential.

In the final article, "A Glimpse into DoD Weapon Systems Programs," by Andy Fainer, the author provides a general overview of sustaining Department of Defense (DoD) weapon systems as part of the overall defense life cycle management process. For the past several decades, billions of taxpayer dollars have been spent on weapon systems annually. The lives of U.S. Armed Forces servicemembers and the people they protect depend upon the quality and sustainment of these weapon systems. This article integrates several major themes such as the 2006 Quadrennial Defense Review (QDR), the 2005 National Defense Strategy, and logistics transformation (including Future Logistics Enterprise). The author also summarizes six Government Accountability Office (GAO) reports in his analysis.

Dr. Paul Alfieri
Executive Editor
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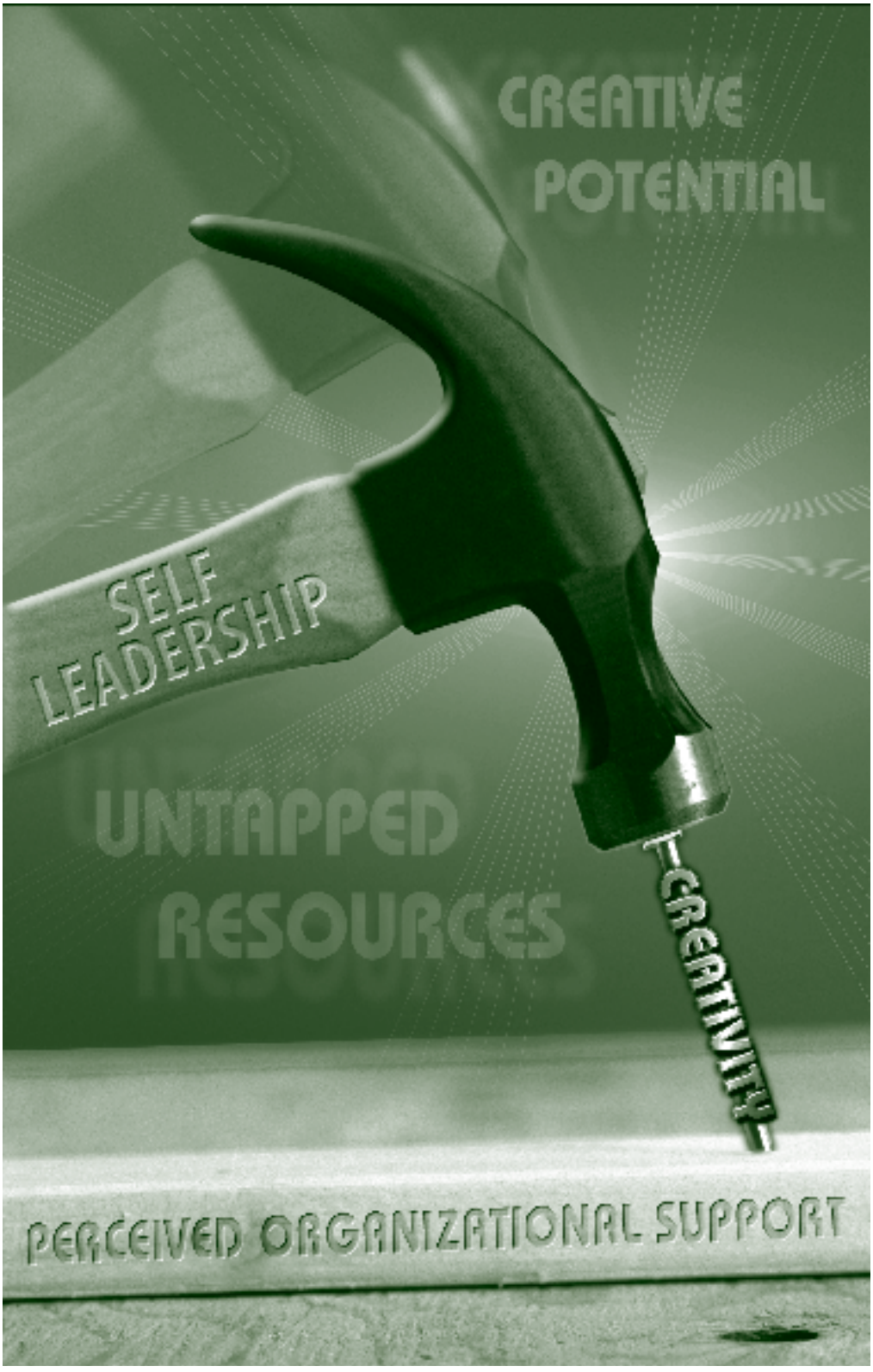

Image designed by Jim Elmore

DOES ORGANIZATIONAL LEVEL INFLUENCE SELF-LEADERSHIP IN THE DEFENSE ACQUISITION WORKFORCE?

Trudy C. DiLiello and Jeffery D. Houghton

This article presents the findings of a study that investigated the relationships between self-leadership and creativity in the context of a defense acquisition organization and its employees. More specifically, this study examined differences in self-leadership, creativity, and perceived organizational support for creativity between line- and supervisory-level defense acquisition employees. The resultant analyses suggested that self-leadership was significantly related to creative potential and practiced creativity for both line- and supervisory-level employees, although there were no significant differences in overall levels of self-leadership between the two groups. In addition, the study findings revealed significant differences in creative potential, practiced creativity, gap scores, and perceptions of organizational support for creativity.

This article presents the findings of a study that addresses the question of whether there are significant and meaningful differences in self-leadership and creativity between line- and supervisory-level defense acquisition employees. Our findings imply that self-leadership is a primary tool for facilitating creativity at all organizational levels and that active organizational support for creativity may be the key for reducing the gap between creative potential and practiced creativity that represents untapped creative resources. Our results suggest that this gap is much more pronounced among line employees, and that line employees generally perceive less organizational support for using their creative resources than supervisors. In response, we make some specific suggestions for organizational interventions designed to increase self-leadership capabilities at all levels and to increase perceptions of organization

support for creative practices among line employees in defense acquisition. Our suggestions, when applied across the defense acquisition workforce, will accelerate the pace at which the Department of Defense (DoD) continues to develop a workforce of creative self-leaders, capable of synergistically assisting organizations in maximizing the leveraging of all organizational resources.

Self-leadership is a concept that focuses on self-reflection and -evaluation aimed at improving personal and professional performance.

BACKGROUND

Innovation and creativity are critical for organizations to thrive in the 21st century (Kanter, 1983; Tushman & O'Reilly, 1997; Utterback, 1994). Indeed, the Business Transformation Agency (BTA) under the Office of the Secretary of Defense (OSD) has placed the leveraging of innovation and creativity among the most effective approaches for creating the transformational changes needed to maintain Department of Defense strategic superiority. Creativity is more likely to occur if an individual has certain characteristics or innate skills and abilities (Tierney & Farmer, 2002; Hinton, 1970; Simonton, 1992; Woodman & Schoenfeldt, 1989) and when the individual perceives that the work environment supports creativity (Amabile, 1996; Cummings, Hinton, & Gobdel, 1975; Woodman, et al., 1993). Furthermore, the ability to leverage creativity depends largely on effective leadership (Kouzes & Posner, 1995; Manz & Sims, 2001). A common theme in improving leadership effectiveness concerns knowing and leading oneself (Bennis, 1994; Drucker, 1999; Goleman, Boyatzis, & McKee, 2002; Senge, 1990; Yukl, 2002). Self-leadership is a concept that focuses on self-reflection and -evaluation aimed at improving personal and professional performance.

Although theorists have often suggested relationships between self-leadership and creativity (e.g., Kouzes & Posner, 1995; Manz & Sims, 2001), very little attention has been given to how these relationships may differ across an organizational level. The purpose of the current study is to address the question of whether there are significant and meaningful differences in self-leadership and creativity between line- and supervisory-level defense acquisition employees. The answer to this question may have important implications for maximizing employee self-direction and for fully leveraging creative resources at all organizational levels.

CREATIVE POTENTIAL AND PRACTICED CREATIVITY

Although creativity is a complex concept that is somewhat difficult to define, consistent themes tend to emerge across the various definitions in the creativity literature (e.g., Barron & Harrington, 1981; Guilford, 1950; Martindale, 1989; Sternberg and Lubart, 1999). Based on the common ideas in these definitions, we define creativity as an ability to harvest novel but appropriate ideas in order to maximize efficiencies, solve problems, and increase effectiveness. We further divide the creativity concept into creative potential and practiced creativity (e.g., Hinton, 1968; DiLiello & Houghton, 2006, 2008). In short, if an individual's creativity is attenuated by the environment, then the individual will not use his or her full creative potential (Hinton, 1968; George & Zhou, 2001; Scott, 1965).

Creative potential is the creative capacity, skills, and abilities that a person possesses (Hinton, 1968, 1970). Creative potential includes the concept of creative self-efficacy, an individual's subjective assessment of his or her personal ability to be creative (Tierney and Farmer, 2002). Creative self-efficacy involves seeing oneself as being good at creative problem solving and generating novel ideas. Creative potential also includes having the talent or expertise to do well in one's work and possessing the ability to take risks by trying out new ideas (Amabile, Burnside, & Gryskiewicz, 1999).

The gap between creative potential and creative practice represents untapped organizational resources.

Practiced creativity, on the other hand, is the perceived opportunity to use creativity skills and abilities. Practiced creativity should not be confused with creative performance, which is an external assessment of products or achievements (Amabile, 1996; Hinton, 1968). Employees with strong creative potential are more likely to actually practice creativity when they perceive strong support from the organization (DiLiello & Houghton, 2006), and several key conditions must be present within an organization for its work environment to support individual creativity (e.g., Amabile, 1988; Ford, 1996; Mumford & Gustafson, 1988).

The distinction between creative potential and practiced creativity is important because when people perceive themselves as having creative potential but do not perceive the ability to use or practice this potential, they will be less likely to engage in creative behavior. The gap between creative potential and creative practice represents untapped organizational resources. Identifying such untapped resources may be especially important in defense acquisition organizations that are continually being told to "do more with less."

PERCEIVED ORGANIZATIONAL SUPPORT FOR CREATIVITY

Over the past two decades, the general concept of perceived organizational support (POS) has become a central organizational construct that has been investigated in a number of empirical studies (Rhoades & Eisenberger, 2002). Based on the concept of social exchange (e.g., Eisenberger Huntington, Hutchison, & Sowa, 1986) and the norm of reciprocity (Gouldner, 1960), POS theory suggests that employees will demonstrate commitment, enhanced performance, and decreased withdrawal behaviors in exchange for fair procedures, support from their supervisor, desirable rewards, and favorable job conditions (Rhoades & Eisenberger, 2002). Research studies have shown empirical linkages between POS and job conscientiousness, job involvement, loyalty, trust in the organization, and decreased turnover (Eisenberger, Fasolo, & Davis-LaMastro, 1990; Eisenberger, Huntington, Hutchison, & Sowa, 1986).

Research has also suggested a relationship between POS and innovation/creativity (Amabile, 1988; Cummings, Hinton & Gobdel, 1975, Eisenberger, et al., 1990; Scott & Bruce, 1994; Shalley, 1995; Woodman, Sawyer & Griffen, 1993; Zhou & George, 2001). Indeed, some researchers have advanced the concept of perceived organizational support for creativity as a specific type of POS in organizations (e.g., Zhou & George, 2001). Perceived organizational support for creativity can be defined as "the extent to which an employee perceives that the organization encourages, respects, rewards, and recognizes employees who exhibit creativity" (Zhou & George, 2001, p. 686). Perceived organizational support for creativity can be further conceptualized in terms of "an organizational culture that encourages creativity through the fair, constructive judgment of ideas, reward and recognition for creative work, mechanisms for developing new ideas and active flow of ideas, and a shared vision of what the organization is trying to do" (Amabile et al., 1999, p. 15). Perceived organizational support for creativity is conceptually distinct from practiced creativity, which focuses more on actual opportunities to use creative skills rather than upon an environment that rewards and encourages creative behavior (DiLiello & Houghton, 2008).

SELF-LEADERSHIP

Self-leadership (e.g., Manz, 1986; Neck & Houghton, 2006; Neck & Manz, 2007) is a self-evaluation and self-influence process through which individuals identify and replace ineffective behaviors and negative thought processes with more effective behaviors and positive thought processes, thereby enhancing personal accountability and improving professional performance. Theorists have long suggested that leaders in organizations should encourage their followers to lead themselves in the workplace (e.g., Manz & Sims, 1980, 2001). Supervisors and work environments only have a limited control over the workers; additional control or work motivation must come from within the individual (Herzberg, Mausner, & Snyderman, 2003; Manz & Sims, 1980; Sergiovanni, 1992). When employees are trained and empowered to lead themselves, supervisors can shift their focus from detailed oversight and control to longer-term big picture issues.

Founded upon several classic theories of self-influence including self-regulation (Kanfer, 1970; Carver & Scheier, 1981), self-control (Cautela, 1969; Mahoney & Arnkoff, 1978, 1979; Thoresen & Mahoney, 1974), intrinsic motivation theory (e.g., Deci and Ryan, 1985), and social cognitive theory (e.g., Bandura, 1986), self-leadership is a normative model that prescribes specific sets of behavioral and cognitive strategies aimed at increasing individual performance. Self-leadership strategies are often divided into three primary categories: Behavior Focused Strategies, Natural Reward Strategies, and Constructive Thought Strategies (e.g., Neck & Houghton, 2006).

When employees are trained and empowered to lead themselves, supervisors can shift their focus from detailed oversight and control to longer-term big picture issues.

Behavior Focused Strategies. This category involves identifying and replacing ineffective behaviors with more effective ones through a process of self-observation, self-goal setting, self-reward, and self-correcting feedback (Neck & Houghton, 2006). Self-observation entails a close examination of one's own behaviors in order to identify behaviors that should be changed, enhanced, or eliminated (Mahoney & Arnkoff, 1978, 1979; Manz & Sims, 1980; Neck & Manz, 2007). Once target behaviors have been identified, individuals can establish goal and associated reward contingencies to energize and direct necessary behaviors (Mahoney & Arnkoff, 1978, 1979; Manz & Sims, 1980; Neck & Manz, 2007). Additionally, self-correcting feedback, consisting of a positively framed reflection on failures and undesirable behaviors, may be quite effective in helping to recast these behaviors in more positive directions (Manz & Sims, 2001).

Natural Reward Strategies. This category includes the ability of the individual to find pleasure in the work that has to be performed and to focus on the inherently enjoyable aspects of task or activity, leading to increased feelings of competence, self-control, and a sense of purpose (Csikszentmihalyi, 1996; Deci & Ryan, 1985; Herzberg et al, 2003). Natural reward strategies include building more pleasant and enjoyable features into a task or activity so that the task itself becomes more intrinsically rewarding, and shifting mental focus to inherently rewarding aspects of the task (Neck & Houghton, 2006; Neck & Manz, 2007).

Constructive Thought Strategies. This category focuses on directing and reshaping various mental processes including beliefs and assumptions, self-verbalizations (self-talk), and mental imagery in order to create constructive thought patterns and habitual ways of thinking that may have a positive impact on individual performance (Neck & Houghton, 2006; Neck & Manz, 1992, 1996). For example, individuals can assess their thought patterns in an effort to identify and eliminate dysfunctional

beliefs and assumptions with more rational and constructive ones (Burns, 1980; Ellis, 1977; Neck & Manz, 1992). Similarly, self-talk, defined as what we covertly tell ourselves, can be closely examined in order to eliminate undue negativity and pessimism. Research in various fields (sports psychology, clinical psychology, education, and communication) supports the use of positive self-talk as an effective way to improve individual performance (e.g., Neck & Manz, 1992). Mental imagery involves symbolically experiencing behavioral outcomes prior to actual performance without overt physical muscular movement (Driskell, Copper, & Moran, 1994; Finke, 1989; Neck & Manz, 1992, 1996). Research suggests that people who visualize successful performance before actually engaging in performance are much more likely to perform successfully when faced with the actual task (Neck & Houghton, 2006). In a meta-analysis of 35 empirical studies, Driskell et al. (1994) reported an overall positive and significant effect for mental imagery on individual performance.

The relationship between creativity and self-leadership may be partially founded on the concepts of autonomy and self-determination.

Theorists have often suggested a relationship between self-leadership and creativity (e.g., DiLiello & Houghton, 2006; Houghton & Yoho, 2005; Manz & Sims, 2001). The relationship between creativity and self-leadership may be partially founded on the concepts of autonomy and self-determination. Autonomy, a key aspect of creativity (e.g., Amabile, 1996; Barron & Harrington, 1981; Woodman et al., 1993), has been linked to self-determination and intrinsic motivation (Deci & Ryan, 1985). Self-determination is a primary component of self-leadership's natural reward strategies (Neck & Manz, 2007). Indeed, empirical research suggests that an individual's need for autonomy can subsequently influence the extent to which the individual engages in self-leadership (Yun, Cox, & Sims, 2006).

Other relationships between creativity and self-leadership have also been suggested. For example, Houghton and Yoho (2005) have suggested a relationship between individual self-leadership and subsequent levels of individual independence and creativity. In addition, internal locus of control, a theorized component of creativity, has been empirically related to individual self-leadership (Kazan & Earnest, 2000). Finally, an empowering leadership style (leading others to be self-leaders) tends to promote creativity rather than conformity (Manz & Sims, 2001). Indeed, creativity may be one of the most essential aspects of effective organizational leadership (Mumford & Connelly, 1999). Creative thinking and a different style of leadership are necessary to provide flexibility, facilitate change, and redesign traditional bureaucratic processes (Katz & Kahn, 1978). Encouraging self-leadership is a relatively

new leadership style that may help to promote an organizational climate that supports creativity. Empowering leadership is rapidly becoming a key success strategy in the rapidly changing work environments of the 21st century.

PURPOSE AND RATIONALE

The purpose of the current study is to examine the relationships between self-leadership and creativity in the context of a defense acquisition organization. Our primary research question is: Are there significant differences in self-leadership and creativity between line- and supervisory-level defense acquisition employees? More specifically, our analysis will address the following questions: 1) Are there significant differences in self-leadership between line- and supervisory-level employees? 2) Are there significant differences in creative potential, practiced creativity, and the gap between the two in line- and supervisory-level employees? 3) Are there significant differences in perceived organizational support for creativity between line- and supervisory-level employees?

The present study contributes to the self-leadership and creativity literature in a number of important ways. First, this study takes an empirical step toward understanding the nature of the relationship between self-leadership and creativity. This study also examines the role of organizational support in facilitating practiced creativity among organizational members. Most importantly, this study is among the first to examine differences in self-leadership, creativity, and perceptions of support between line- and supervisory-level employees. Understanding these differences may be critical for reducing the gap between creative potential and practiced creativity in organizations. Finally, this study makes a unique contribution to our knowledge of creativity and self-leadership in the context of defense acquisition. The differences examined here may have important implications for creating a defense acquisition workforce with strong self-leaders working in environments that support creativity. Creative self-leaders could synergistically assist the DoD in maintaining an all-important competitive advantage in the face of a wide range of 21st century challenges.

METHOD

SAMPLE AND PROCEDURE

Primary data were collected from the Army Contracting Agency (ACA) as part of a larger study that examined a number of performance-related issues. Approximately 37 percent of the total ACA workforce of approximately 1,900 people chose to complete the online survey—a fairly high response rate when compared to the response rates for other federal employee surveys and with response rates for e-mail surveys in general (Sheehan, 2001). List-wise, deletion for missing data resulted in a final overall sample of 654. This sample was subsequently divided into two subsamples (i.e., supervisory employees, N=215; and line employees, N=439) for further analysis. The average age of the respondents was approximately 46, and the average job tenure was

approximately 12 years. Sixty percent of the respondents were female. The online survey was activated in accordance with the tailored design method (Dillman, 2000). An initial e-mail was sent to ACA workforce members that included an Informed Consent Notification, the purpose of the study, the approval and sponsorship of the study, a confidentiality statement, and a link to the online survey. A subsequent follow-up e-mail summarized the first message, added a personal note, and provided a four-day extension along with a link to the online survey.

MEASURES

Self-leadership. Thirteen items from the Revised Self-leadership Questionnaire (RSLQ, Houghton & Neck, 2002) were used to measure self-leadership. The RSLQ has been used to measure self-leadership in numerous studies (e.g., Houghton & Jinkerson, 2007; Houghton, Bonham, Neck & Singh, 2004; Neubert & Wu, 2006). The 13 items demonstrated good reliability in the current sample with an alpha coefficient of .80—well above Nunnally's (1978) recommended threshold of .70. The items were measured using a five-point Likert-type scale ranging from Completely Accurate to Not At All Accurate.

Creative potential and practiced creativity. Eleven items were used to measure creativity, with six items assessing creative potential and five items representing practiced creativity (DiLiello & Houghton, 2008). DiLiello and Houghton (2008) assessed the construct and discriminant validity of the creative potential and practiced creativity concepts using an exploratory factor analysis (EFA) along with a confirmatory factor analysis (CFA) using structural equation modeling techniques. Their EFA demonstrated a clean factor structure for each construct with strong factor loadings and virtually no cross-loadings for any of the items, while the reliability of the items used to measure each construct was also quite good, with coefficient alphas of .84 for each of the two constructs (DiLiello & Houghton, 2008). CFA results also provided additional evidence in support of the construct and discriminant validity of these concepts (DiLiello & Houghton, 2008). Items were measured using a five-point Likert-type scale ranging from Strongly Agree to Strongly Disagree.

Perceived organizational support for creativity. Perceived organizational support for creativity was measured with six items from "KEYS: Assessing the Climate for Creativity," used with the permission of the Center for Creative Leadership (Amabile et al., 1999). The KEYS scale has shown good psychometric properties as evidenced by CFA results and by median reliability estimates of .84 across a number of studies (e.g., Mathisen & Einarsen, 2004). All items were measured using a five-point Likert-type scale ranging from Strongly Agree to Strongly Disagree.

ANALYSES

Mean differences between supervisory and line employees for self-leadership, creative potential, practiced creativity, a gap score (i.e., the difference between creative potential and practiced creativity that represents untapped creative potential), and perceptions of organizational support for creativity were examined using a series of t-tests. In addition, a series of regression analyses were conducted to examine the

effects of self-leadership, perceived organizational support for creativity and organizational level (line vs. supervisory) on creative potential, practiced creativity, and gap scores, respectively, along with the effects of organizational level (line vs. supervisory) on perceived organizational support for creativity.

RESULTS

Means and standard deviations for both supervisory and line employees for self-leadership, creative potential, practiced creativity, gap scores, and perceived organizational support for creativity are shown in Table 1. The analysis indicated no mean difference between groups for self-leadership, t(507df) = 1.16, p = .247. In contrast, analyses showed significant mean differences between the two groups for creative potential, t(652df) = 3.30, p = .001; practiced creativity, t(469df) = 7.48, p = .000; gap scores, t(471df) = -5.03, p = .000; and perceived organizational support for creativity, t(652df) = 3.21, p = .001.

Four separate regression analyses were conducted. Model 1 examined the effects of the independent variables self-leadership and organizational level (1=supervisor - 0=line, using dummy variable coding) on the dependent variable creative potential. Model 2 examined the effects of self-leadership, perceived organizational support for creativity, and organizational level on the dependent variable practiced creativity. Model 3 examined the relationships between the three independent variables and gap scores. Finally, Model 4 explored the effects of organizational level on perceptions of organizational support for creativity. A summary of the results of these analyses is presented in Table 2.

The regression equation for Model 1 suggested that both self-leadership and organizational level were significantly related to creative potential, with self-leadership as the stronger predictor of the two (Standardized ß = .356, p = .000). The equation for Model 2 indicated that self-leadership, perceived organizational support for

TABLE 1. MEANS AND STANDARD DEVIATIONS (IN PARENTHESES)

	SL	CP	PC	GS	OS
Supervisors	49.55	25.47	23.58	1.89	20.00
N=215	(6.10)	(2.98)	(4.04)	(4.10)	(5.40)
Line Employees	48.92	24.65	20.97	3.68	18.54
N=439	(7.43)	(3.03)	(4.51)	(4.60)	(5.46)

Note. SL=Self-Leadership, CP=Creative Potential, PC=Practiced Creativity, GS=Gap Score, OS=Perceived Organizational Support.

creativity, and organizational level were all significant predictors of practiced creativity, accounting for approximately 42.6 percent of its variance. Of the three variables, perceived organizational support was the stronger predictor of practiced creativity (Standardized ß = .563, p = .000). The Model 3 analysis found that perceived organizational support and organizational level were significantly and negatively related to gap scores, explaining approximately 33.1 percent of the observed variance. The regression equation suggested a strong negative effect for perceived organizational support (Standardized ß = -.551, p = .000), indicating that lower perceptions of organizational support for creativity will result in larger gaps between an individual's creative potential and their practiced creativity. In addition, the equation suggests that gap scores will be significantly greater for line employees than for supervisors (Organizational Level: Standardized ß = -.117, p = .000). Finally, the regression analysis for Model 4 implied that supervisors tend to have more positive perceptions of organizational support for creativity than line employees (Organizational Level: Standardized ß = .125, p = .001).

TABLE 2. SUMMARY OF REGRESSION ANALYSES RESULTS

Independent Variables	Model 1: *ß*	Creative Potential *p* - value	Model 2: *ß*	Practiced Creativity *p* - value	Model 3: *ß*	Gap Score *p* - value	Model 4: *ß*	Organizational Support *p* - value
Self-Leadership	.356	.000	.158	.000				
Perceived Organizational Support			.563	.000	-.551	.000		
Organizational Level	.113	.002	.195	.000	-.117	.000	.125	.001
Adjusted R^2	.140		.426		.331		.014	
F Statistic	54.25		162.84		162.53		10.32	
p - value	.000		.000		.000		.001	

DISCUSSION

This study revealed a number of significant differences between line and supervisory defense acquisition employees. Our analyses suggested that self-leadership was significantly related to creative potential and practiced creativity for both line- and supervisory-level employees with no significant differences in overall levels of self-leadership between the two groups. In contrast, we found significant differences between line- and supervisory-level employees in creative potential, practiced creativity, gap scores, and perceptions of organizational support for creativity. Specifically, line employees reported significantly lower levels of creative potential, practiced creativity, and perceptions of organizational support for creativity along with higher gap scores in comparison to supervisors.

Self-leadership appears to be the more important concept in determining an individual's creative potential.

Our analyses further suggested that although supervisors tend to have more creative potential than line employees, self-leadership appears to be the more important concept in determining an individual's creative potential. Likewise, although self-leadership and organizational level are both important determinants of practiced creativity, employee perceptions of organizational support for creativity seem to be far more crucial. Similarly, perceived organizational support for creativity appears to be more important than organizational level in predicting creativity gaps in acquisition employees. In other words, employees who feel that the organization supports their creative efforts will be much more likely to practice creative behaviors, thus lowering the gap between their potential and practiced creativity. Finally, organizational level was a significant determinant of perceptions of organizational support for creativity, with supervisory employees holding significantly more positive perceptions of support than line employees. In summation, our analyses suggest that self-leadership may be a key determinant of creative potential and practice among defense acquisition employees; and that perceptions of organizational support for creativity, which tend to be weaker in non-supervisory employees, are critical in determining whether creative potential will be realized or whether a gap between potential and practice will result.

The results of this study have important theoretical, empirical, and practical applications that add to our understanding of the nature of the relationship between self-leadership, creativity, and organizational support for creative practices at both the supervisory and non-supervisory levels. Our findings imply that self-leadership is a primary tool for facilitating creativity at all organizational levels and that active organizational support for creativity may be the key for reducing the gap between

creative potential and practiced creativity that represents untapped creative resources. Our results also suggest that this gap is much more pronounced among line employees and that line employees generally perceive less organizational support for using their creative resources than supervisors. To address this situation, an organizational intervention designed to increase self-leadership capabilities at all levels and to increase perceptions of organization support for creative practices among line employees in defense acquisition would be well advised. More specifically, a structured self-leadership training program similar to those reported elsewhere in the literature (e.g., Neck & Manz, 1996; Stewart, Carson, & Cardy, 1996) could be conducted for defense acquisition employees. Such a training program could have the dual effect of increasing self-leading behaviors and thus creative potential while also strongly signaling organizational support for creative behaviors.

Employees who feel that the organization supports their creative efforts will be much more likely to practice creative behaviors.

Although our findings suggest exciting avenues toward increasing self-leadership and unleashing creative resources at all organizational levels, our study is bound by certain limitations. First, the present sample was relatively homogeneous, consisting entirely of members of the ACA. As we have suggested, such a sample is especially appropriate for creativity research because the DoD has taken a keen interest in tapping all creative resources available in order to sustain a competitive advantage. However, whether the results reported here would generalize to other samples of interest remains uncertain. Second, all items were self-reported and collected using a single survey at a single point in time, thus raising concerns regarding measurement issues such as response set and social desirability biases. Given this potential problem, our findings should be viewed with some degree of caution. On the other hand, despite such inherent limitations, the use of self-reported items collected in a single administration is common practice in many aspects of social science research. Finally, it is impossible to determine, based on these data and statistical techniques alone, the direction of causality for the observed relationships. Direction of causality must be inferred by underlying theory. Although we have advanced empirical and theoretical arguments supporting the possible direction of causality for the various relationships reported here, these arguments cannot be unequivocally substantiated on the sole basis of statistical test results.

Future research should continue to examine the relationships between self-leadership, creative potential, practiced creativity, organizational level and organizational support for creativity. Specifically, future research should more closely examine the

role of organizational support as a moderator of the relationship between creative potential and practiced creativity and as a key mechanism for reducing the gap between these concepts in organizations. In addition, perceptions of support for creativity might be further subdivided from the organizational level to the work group and supervisory levels in order to provide additional insights (DiLiello & Houghton,

An acquisition workforce of creative self-leaders could synergistically assist the organization in maximizing the leveraging of all organizational resources.

2006). Similarly, future research could continue to examine the differences between line- and supervisory-level employees in terms of creativity and perceptions of support for creative practices, with an eye toward identifying ways to increase creativity at all organizational levels. In closing, our findings and suggestions have significant practical application in the context of transformational efforts across the DoD in support of warfighter readiness. An acquisition workforce of creative self-leaders could synergistically assist the organization in maximizing the leveraging of all organizational resources.

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LESSONS FROM THE DEVELOPMENT OF ARMY SYSTEMS

William A. Lucas and Richard G. Rhoades

Several of the statistically significant relationships found in this study of 13 Army systems involve factors that are related to the stability of the program. For example, uncertainty of a project's future and funding cutbacks are found to have a strong predictive influence on development program effectiveness, which may be explained in part by their impact on program staffing turnover and the disruption of testing regimes. A central conclusion from this study is that shorter development cycle times favorably correlate with lower levels of these sources of program instability, and with substantially better project outcomes.

This article is based on the results of Army Materiel Command-sponsored research of several years' duration (Lucas & Rhoades, 2004). A structured case study approach was employed to examine the history and processes that had resulted in the introduction of a number of technology-based Army systems in time to make a positive contribution to the outcome of DESERT STORM. The 13 case studies that resulted were developed on systems ranging from the M829A1 "silver bullet" to the GUARDRAIL Common Sensor and the APACHE attack helicopter.

METHODOLOGY

The case studies were prepared largely based on interviews with key participants from the government/contractor team that developed each system, and using a research questionnaire to structure the discussions. The authors designed the questionnaire to provide coverage of a number of development process, organizational relationship, critical technology maturity, and other factors that either the authors' prior experience or the literature (GAO, 1999; GAO, 2000) suggested might be relevant to determining the relative success of projects. A portion of the questionnaire consisted of questions that were in common with a research instrument successfully used by one of the authors in a prior study (Air Force Research Laboratory, 2002) of

aerospace research projects. This process resulted in collection of a common set of data for the systems studied, which could then be analyzed to identify factors contributing to the relative degree of success in system development.

The heart of any systematic analysis is the definition of a common outcome measure that allows comparison.

The heart of any systematic analysis is the definition of a common outcome measure that allows comparison. In this study, the projects (cases) were compared based on their performance relative to their agreed-upon goals and requirements. Each project had a budget, a systems procurement cost goal, a set of technical requirements, and completion dates. In addition, questions of performance are immediately observable and easily remembered by project managers: Once production was started, were problems found that required that further engineering changes be made? And did the system perform well during its use in DESERT STORM? Using structured questions, the researchers asked the key government and industry interviewees how well their projects performed in these areas, with a range of answers that characterized how badly the projects had missed meeting their objectives if they had not been completely successful. Note that researchers developing each case study had the independent views of at least two senior managers, as well as their own detailed study of their project, to enable them to make summary judgments on project success meeting these largely observable outcomes.

Six of these outcome measures were used to create a scale that scores the projects from zero to six according to the number of key outcomes a project achieved. If a project was (a) transitioned to production on time, (b) developed within budget, (c) had no late engineering changes, (d) met the goals for system unit costs, (e) met the goals for technical requirements, and (f) encountered no difficulties when deployed in the field, it was awarded six points on this scale. These results appear in the third column of Table 1.

FACTORS INFLUENCING STABILITY

Previous reports on systems development have noted the importance of various factors that influence the stability of system acquisition programs. As part of this research, program funding uncertainty and cutbacks, changes to the system requirements (e.g., changes to the threat the system was being designed to defeat), and changes in key military personnel representing the user community (e.g., Training and Doctrine Command) were all examined to see to what extent any or all of these

TABLE 1. SUMMARY CASE INFORMATION

SYSTEM/CASE	DEVELOPMENT DURATION (MONTHS)	KEY OUTCOMES ACHIEVED (0-6)	COMPLEXITY (LOW, MEDIUM, HIGH)
APACHE attack helicopter	108	1	High
TADS/PNVS (target acquisition and designation/pilot's night vision systems)	~36	3	Medium
MLRS rocket system	33	6	Low
ATACMS missile system	37	6	Medium
M40 chemical protective mask	~48	2	Low
Mounted microclimate cooler	~24	5	Low
M829-A1 armor–piercing kinetic energy tank ammunition	~36	6	Low
TOW-2A (Tube-launched missile)	48	3	Low
AN/TAS 4 infrared night sight	~24	4	Low
Joint Stars Ground Station	105	1	Medium
Guardrail common sensor	~24	3	Low
PAC-2 (PATRIOT anti-missile system)	~52	2	Medium
HELLFIRE missile system	~84	3	High

TABLE 2. PROGRAM STABILITY

Type of Instability	Question/Response
Funding uncertainty	6 of 12 disagreed strongly that there was uncertainty about the future of project funding.
Project slow-down	8 of 13 projects were not stopped and restarted or slowed down.
Funding cut-backs	5 of 13 escaped changes or compromises forced by cut-backs in project resources.
Turn-over in Army user representatives	All projects experienced changes in key TRADOC personnel during development. This occurred only once or twice for 7 of 13.
Change in systems requirements	4 of 13 had no changes in systems requirements during development.
Change in system requirements	4 projects experienced systems requirement changes* in the middle of development; in 3 these changes occurred late in development

**Responses selected as many periods as applicable from the stages of planning; early, mid- and late development; and transition.*

"instabilities" impacted program outcomes. Table 2 contains the aggregate results from questions that were used in the research, categorized by type of instability.

A somewhat surprising result is that there was widespread occurrence of all these forms of instability in the pre-DESERT STORM development programs studied here. Looking back at the successful performance of new Army systems in DESERT STORM, one might think that their development benefited from strong and stable environments, but the evidence shows that the external environment then was not unlike what one might find today.

FINANCIAL UNCERTAINTY AND PROJECT CUTBACKS

Where potential or actual funding changes were encountered ("financial uncertainty"), it appears to have had significant consequences. When one looks at the projects that are reported to have been slowed (i.e., experienced a lengthening of the planned development phase), all five also experienced problems due to financial cutbacks. By comparison, only three of eight that were not slowed experienced problems due to cutbacks (Table 3). While program slow-down may be caused by a variety of factors besides or in addition to budget cuts, once slowed, programs seem to have continuing financial problems. Given that cutbacks are often the first signal that a

TABLE 3. FUNDING INSTABILITY AND FORCED CHANGES AND COMPROMISES

A. Often uncertainty about future of project funding?		
Cut-backs forced changes	Other responses	Strongly disagree
Changes were forced by cut-backs	8	0
No changes forced by cut-backs	2	3
Total	10	3

Tau B = 0.683, significant at .001.

B. Was project slowed down?		
Cut-backs forced changes	Slowed down	Kept on schedule
Changes were forced by cut-backs	5	3
No changes forced by cut-backs	0	5
Total	5	8

Tau B = 0.688, significant at .001.

program's future is at risk, these results are expected and provide reassurance that the survey respondents' judgments of the projects are consistent.

The earlier LeanTEC research that has influenced the design of this investigation found that there were some ties between funding stability and project performance. Veteran professionals in the aerospace industry recalled a number of projects that were weakened by perceptions that project funds were limited or at risk. They suggested that when funding seemed threatened, development team engineers had a

Financial uncertainty and cutbacks are found to relate strongly to turnover.

tendency to migrate to other, more stable projects, causing turnover. Being able to bill to multiple engineering charge numbers gives the individual substantial security and control over his or her work if the primary project encounters financial cutbacks or is cancelled. Other interviewees suggested that worry about continued funding led management and team leaders to cut back on staffing or otherwise reduce costs to stretch the project out. Whatever the reasons, respondents were confident that they had seen a substantial number of projects where funding uncertainties had directly contributed to poor team performance due to team turnover and inadequate staffing.

TABLE 4. FUNDING INSTABILITY AND STAFF TURN-OVER

A. There was uncertainly about future funding		
Members turned over?	Other responses	Strongly disagree
Other responses	6	0
Disagree, no turnover	1	6
Total	7	6

Tau B = 0.667, significant at .001. Missing data for one case.

B. Cut-backs forced changes?		
Members turned over?	Forced changes	No changes forced
Other responses	6	0
Strongly disagree, no turnover	2	5
Total	8	5

Tau B = 0.635, significant at .001.

The results from this present study of Army systems support that view. When one looks in turn at how these questions about financial stability relate to other key factors, strong, negative relationships are found with staffing stability and effective testing. In particular, both financial uncertainty and cutbacks are found to relate strongly to turnover. Of six projects where respondents reported little or no funding uncertainty, none are reported to have had turnover. For the remaining projects where funding was more uncertain, six of seven experienced turnover (top, Table 4). When one compares the projects that didn't have compromises or changes forced by cut-backs with those that did, the results show that all five projects with no cutbacks also had no turnover. By contrast, six of the eight projects that experienced cutbacks also experienced turnover (bottom, Table 4).

A NOTE ON STATISTICS

Despite the limitation that the analysis only includes 13 cases, the Tau B statistical test appropriate for these variables (Blalock, 1960) shows that the strength of the relationship between the two variables is sufficiently strong that it could have happened by chance less than one time in a thousand ($p < .001$). One can thus have confidence that the reported relationships are statistically meaningful despite the small number of programs being studied.

Project cutbacks and financial stability were also found to all relate to the effectiveness and the appropriate timing of the testing used in the program. One might readily understand that slowing projects could disrupt testing schedules, and that

TABLE 5. FUNDING INSTABILITY AND THE TIMING OF TESTING

A. Was project slowed down?		
Appropriate timing of testing?	Slowed down	Kept on schedule
Other responses	4	2
Strongly agree	1	6
Total	5	8

Tau B = 0.620, significant at .004.

B. Cut-backs forced changes		
Appropriate timing of testing?	Occurred	None
Other responses	5	1
Strongly agree	3	4
Total	8	5

Tau B = 0.610, significant at .002.

investment in testing might be a casualty of budget cuts. For projects slowed during the life of the program, four of five cases did not conduct timely testing activities. For projects that stayed on schedule, six of eight were reported as having conducted appropriate testing (top, Table 5). Cutbacks could cause testing changes and compromises, which could lead to the conclusion that testing was negatively affected. Four out of five cases that did not have any changes forced by cutbacks also had appropriate testing; only three of eight programs that were slowed are reported confidently as having appropriately timed their testing activities (bottom, Table 5).

Experience suggests that stretching projects disrupts schedules, and that cutbacks and changes often lead to the need to repeat old test procedures or design new ones.

Experience suggests that stretching projects disrupts schedules, and that cutbacks and changes often lead to the need to repeat old test procedures or design new ones. That and the presence of turnover mean that revised testing programs are sometimes prepared by different individuals from those who designed the system and supported its integration. Whatever the mechanisms, the general conclusion from these results is that funding instability seriously affects staffing and the quality of testing, which were in turn shown in the research to be key predictors of program performance.

TABLE 6. FINANCIAL INSTABILITY AND PROJECT PERFORMANCE

Average number of successful outcomes and number			
	Other responses	Positive response*	Signif. at
Stability and funding:			
Uncertainty about project funding?	2.80 (10)	5.67 (3)	.001
Project ever slowed down?	1.80 (5)	4.50 (8)	.001
Turn-over on development team?	2.00 (7)	4.71 (6)	.001

**The positive responses are, in order: to disagree strongly that funding was uncertain, to say the project was never slowed or interrupted, and disagree that there was any team turnover.*

The overall effect of financial-related problems on project performance is summarized by looking at the average number of successful outcomes (Table 6). The six cases that had little or no problem with uncertain funding had an average of 5.67 successes out of a possible 6.0; those that did face this uncertainty averaged 2.80. Cases that were never slowed averaged 4.50 successes compared with 1.80 for those that were slowed. The impact on outcomes of the relationship between the funding environment and staffing is also seen; projects that experienced turnover averaged 2.0 successes, while those that avoided turnover averaged 4.71. It might be argued that financial uncertainty and cutbacks follow when projects encounter other difficulties, in which case one could expect that these differences in averages would be higher than those found for other factors. Nevertheless, when funding problems are present, there is little doubt that they are strongly associated with turnover and poor development performance for these DESERT STORM cases.

SIGNIFICANT CHANGES IN SYSTEMS REQUIREMENTS

As with other forms of instability, considerable anecdotal evidence suggests that significant changes in systems requirements will adversely impact program outcomes, particularly schedule and/or cost. Consequently, the existence of this evidence makes experienced project managers extremely wary of permitting any changes in system requirements to occur. Sometimes, however, actions on the part of potential adversaries, referred to as "changes in the threat," can force the issue.

In the 13 cases studied, only 3 reported no change to system requirements once a system concept had evolved, and only 4 reported no change during the development phase of the project. In those cases that experienced change during development, three were judged to have required "significant" or "major" effort to make the change, while the remaining six only required "minor" or "very minor" effort. Moreover, some cases experienced multiple instances of requirements change dur-

TABLE 7. CHANGING SYSTEMS REQUIREMENTS AND PROJECT OUTCOMES

A. Frequency of changes in systems requirements		
System met cost goals?	Several, or Many times	None, or One or two times
Fell far short of cost goals	1	0
Came close to cost goals	3	3
Met or exceeded cost goals	0	6
Total	4	9

Tau B = 0.620, significant at .003.

B. Frequency of changes in system requirements		
Late engineering changes after production had started	Several, or Many times	None, or One or Two times
Significant changes	2	0
Minor changes	2	6
None, almost none	0	3
Total	4	9

Tau B = 0.537, significant at .004.

ing development, with four of the nine describing encountering "several" or "many" changes. The remainder reported "no change," or only "one or two instances" of change. The frequency of these changes seems to be at variance with the relatively stable doctrinal and operational environment prior to DESERT STORM.

When changing requirements are related to other variables, the results support the conventional wisdom that such changes are costly.

When changing requirements are related to other variables, the results support the conventional wisdom that such changes are costly. Significant correlations were found between three requirements change variables and several of the outcome metrics. None of the four projects that had several (three cases) or many (one case) requirements changes met their cost goals (top, Table 7), and none of the four avoided

TABLE 8. STABILITY OF SYSTEMS REQUIREMENTS AND PROJECT PERFORMANCE

Average number of successful outcomes			
Mid-development requirements change?	Changes occurred	No changes	Signif. at
	2.00 (4)	4.11 (9)	.005
Frequency of systems requirements change?	Several or Many times	None, or One or two times	Signif. at
	1.50 (4)	4.33 (9)	.006

late engineering changes (bottom, Table 7). For those that had none or only one or two systems requirements changes, six of nine met their cost goals, and three of nine avoided (even minor) late engineering changes. Weaker but similar negative differences on other outcomes (not shown) are found among those projects that experienced more requirements changes.

One can see the overall effects of the frequency and timing of systems requirements changes by looking at how many successful outcomes these projects had on average. The respondents were asked in what stage of development the requirements had changed, and it was found that the negative impact on the average rates of success was greatest when changes had occurred in mid-development (typically after the Critical Design Review). As shown in Table 8, the four projects that had systems requirement changes in mid-development had only an average of 2.0 positive performance outcomes, compared to 4.11 average positive outcomes of those that did not change in mid-development.

The impact is even greater when one looks at the frequency of requirements changes and the average number of successful outcomes. The four projects said to have seen systems requirements changes several or many times during development averaged only 1.50 successful outcomes, compared to 4.33 successes among those projects that had no or only one or two systems requirements changes.

TURNOVER IN KEY USER PERSONNEL

The U.S. Army Training and Doctrine Command (TRADOC) is responsible for determining the requirements that Army materiel must meet in order to have utility on the battlefield. A senior TRADOC staff member (typically a colonel) serves as the alter ego of the Project Manager in interpreting these requirements as they are translated into system technical requirements during the acquisition process. This key individual may also play a critical role in preserving the planned funding for the system development by persuading more senior TRADOC leaders to strongly reaffirm the need for the system when budget cuts are threatened or problems are encountered in the system development that increase cost or stretch schedule. The frequency and timing of turnover in key TRADOC personnel were examined to determine influence on project outcomes.

TABLE 9. CONTINUITY OF TRADOC STAFFING

Did TRADOC change during early development?		
Operational problems in the field?	Yes	No
Field problems limited effectiveness	4	1
Deployed at no loss of effectiveness	1	4
Exceeded expectations	0	7
Total	5	7

Tau B = 0.630, significant at .001. Data are available on 12 cases for this TRADOC question.

All of the respondents reported that their projects had experienced some turnover in key TRADOC personnel. Only two reported no key TRADOC personnel changes during the development phase of the project. Such regular change is consistent with the military reassignment cycle. The timing of when TRADOC key personnel turnover occurred correlated with several of the outcome metrics, most notably with the extent to which the system met expectations when used on the battlefield during DESERT STORM. Table 9 shows the negative impact of staff change early in development on system performance on the battlefield. Key TRADOC personnel changed for five cases during early development, and four of those projects subsequently encountered operational field problems. Where there was no early TRADOC change, only one of seven projects was not as effective as expected.

Cases that experienced no TRADOC changes in early development, however, are seen to be substantially more successful at an average of 4.29 successful outcomes.

The only two cases—Night Sight and the M829A1 sabot round—that did not experience TRADOC changes during the development phase are the same two cases that the respondents felt exceeded performance expectations in the field.

To further examine the possible impact of TRADOC changes at different stages of the project, one can again look at the average number of goals met for the different projects. No relationships of consequence are found between TRADOC change in mid- and late development and the average number of successful outcomes. Cases that experienced no TRADOC changes in early development, however, are seen to be substantially more successful at an average of 4.29 successful outcomes, compared to an average of 2.40 for those that did have TRADOC changes at that time.

TABLE 10. TRADOC CHANGES AND PROJECT PERFORMANCE

Average number of successful outcomes			
TRADOC change during early development?	Staff change	No change	Signif. at
	2.40 (5)	4.29 (7)	.011

TABLE 11. CHANGING SYSTEMS REQUIREMENTS AND KEY TRADOC PERSONNEL

TRADOC change in early stages* of project?			
Did system requirements change during mid development?	No change	In one stage	In both stages
No	5	3	0
Yes	0	2	2
Total	5	5	2

Tau B = 0.0685, significant at 0.001 **pre-development or early development*

One would expect that the doctrinal and operational underpinning for the systems' requirements should have been relatively constant (during this late Cold War period), but the authors found a substantial number of changes in systems requirements for these cases. The question, therefore, lingers: Did the changes in TRADOC personnel found here somehow play a role? New personnel may not feel that their predecessors had correctly defined the threat's implications on requirements, or having not been a party to earlier discussions, been more willing to pursue changes suggested by new

The most damaging requirements changes are those that occur in mid-development.

knowledge and events. This suggestion raises the possibility that TRADOC personnel change could have adverse, indirect effects by somehow permitting changes in systems requirements that have, in turn, a negative impact on project performance.

This study analyzed the relationship between early TRADOC staff changes and shifts in systems requirements and found some support for that view. As noted previously, the results in Table 10 suggest that the most damaging requirements changes

TABLE 12. PROJECT DURATION, INSTABILITY AND FIELD PERFORMANCE

How often did systems requirements change?	Three years or less	Four years or more
Never	4	0
Once or twice	3	2
Several or many times	0	4
Total	7	6

Tau B = .723, significant at .001.

Did system have operational problems in the field?		
Did not meet expectations	1	4
Met expectations	4	2
Exceeded expectations	2	0
Total	7	6

Tau B = -.556, significant at .003.

are those that occur in mid-development. To look for a relevant relationship, one can aggregate TRADOC changes by asking whether there were key staff changes during the technology selection/planning period or during early development (the two earliest time slices in the project). One can then compare the projects that did or did not have these early key TRADOC personnel changes. Table 11 shows that five projects avoided early TRADOC changes, and none of the five had mid-development changes in systems requirements. Of the five projects that had TRADOC changes in one of these early stages, two experienced requirements changes. The two projects that had TRADOC changes in both planning and early development saw later requirements changes in mid-development. It would appear that TRADOC turnover in the early stages of projects is in some way related to mid-development changes in systems requirements.

CONCLUSIONS

Taken together, these several relationships strongly suggest that stability of program resources, staffing, and objectives is a very powerful influence on the relative success of projects. Certainly, as has been noted, a wealth of anecdotal evidence suggests that this should be the case. In reflecting on this array of instabilities that could impact a system development, it became clear that they had at least one thing in common. That is, the longer a system stayed in development, the greater chance it had to experience one or more of these program destabilizing events.

Support for this view is found when the occurrence of cutbacks and systems requirements changes are related to the duration of the 13 development projects studied

TABLE 13. LENGTH OF PROJECT DEVELOPMENT AND PROJECT PERFORMANCE

Average number of successful outcomes			
Project duration?	Three years or less	Four years or more	Signif. at
	4.71	2.00	.001

here. The projects divided cleanly between 7 that took 37 months or less, and 6 that took 48 months or more. When the frequency of systems requirements changes is considered, longer duration clearly allows more time for changing external conditions and priorities to lead to changes in systems requirements. Four of seven of the shorter projects never experienced any changes in requirements, and the remaining three only experienced minimal changes. None of the six projects that ran four years or longer avoided requirements changes, two saw changes once or twice, and four experienced either several or many changes. The pattern is quite strong and statistically significant despite the limited number of cases (top, Table 12).

Given that longer schedules increase the risk of encountering instabilities, it is then not surprising that project duration is also negatively related to achieving desirable project outcomes. For example (bottom, Table 12), one of the strongest relationships between development duration and project outcomes is found for how the system performed in the field. Six of the seven systems developed in (about) three years or less met or exceeded expectations when they were deployed in DESERT STORM, compared to only two of six of the longer projects. The effect on all six outcome questions is seen in Table 13 with the projects requiring longer development time averaging success on only two outcomes, where the shorter development projects had an average 4.7 successful outcomes.

The sensitivity of this central conclusion to project complexity was examined using a measure of relative complexity (Table 1) developed for this purpose. More complex projects often require longer development cycles and are more likely to experience funding difficulties. However, complexity is much more weakly related with staffing turnover than is project duration, and differences in complexity are not found to be at all related with changes of TRADOC personnel or changes in systems requirements. Complexity is also not related to testing quality and timeliness; both of these factors are strongly (and positively) correlated with outcomes. Importantly, duration alone is more strongly related than complexity to the number of successful outcomes. Whether or not complexity plays a role, project duration has a strong effect on outcomes independent of the influence of complexity.

The evidence here is that time is not an ally of systems development. The passage of time and the inevitable intrusion of new knowledge open the door to new pressures. Financial uncertainty is created in part by the need for resources for newer projects, often leading to staffing doubts about the current program and/or the appearance of new opportunities where key personnel are also needed. Or, simple career progression incentives lead people after time to move on, taking knowledge

and experience with them. An obvious conclusion is that programs undertaken for around three years or less involve less risk of destabilizing factors outside the control of program managers. These data then suggest that it is better to organize and budget projects for shorter time frames whenever possible. If projects must be planned to take four years or longer in development, this research suggests that one should recognize that longer projects open the way for substantial pressures that may be difficult to resist, and then plan to deal with instability. Of the several factors considered in this study, the areas that should receive particular attention in longer projects are the need not to take advantage of the expanded opportunity to change systems requirements, to keep key user representatives in their positions during the critical early program phases, to provide incentives and career planning to avoid turnover in key development personnel, and to ensure that cutbacks and rescheduling do not compromise testing regimes.

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HOW TO MAKE INCENTIVE AND AWARD FEES WORK

Alan S. Gilbreth and Sylvester Hubbard

Incentive and award fees are not driving performance outcomes as originally envisioned. In 2005, the Government Accountability Office (GAO) identified an apparent disconnect between the use of certain measures like incentive and award fees and expected outcomes in major acquisitions (GAO, 2005). In response to the GAO report, the authors conducted a research effort to better understand where incentive and award fees had favorable impact on performance outcomes and why. This article summarizes the findings of the research, highlights several organizations that clearly used techniques that drove favorable outcomes, and provides recommendations and take-aways that will promote effective and efficient incentive and award fee programs.

Recently, major acquisition activities have received significant attention due to failure to achieve desired outcomes, such as meeting cost and schedule goals and delivering desired capabilities. The GAO has looked closely at the effectiveness of incentives in DoD contracts. They selected a sample of 93 contracts from a study population of 597 DoD incentive and award fee contracts that were active between fiscal years 1999 and 2003. Fifty-two contracts (56 percent of the sample) were award fee, 27 contracts (29 percent of the sample) were incentive fee, and 14 (15 percent of the sample) included both incentive and award fee provisions. The GAO published their report in December 2005 (GAO-06-66) and asserted that "DoD has paid billions in incentive and award fees without favorably influencing performance outcomes" (GAO, 2005).

In response to the GAO report, then Under Secretary of Defense for Acquisition, Technology and Logistics Ken Krieg directed the Defense Acquisition University (DAU) to conduct a research effort to better understand where incentive and award fees had a favorable impact on performance outcomes and what made these programs effective. The goal of the research was not to validate or reclama the GAO study. Instead, the research effort was to investigate where the acquisition community implemented award and incentive fee practices that had a favorable impact on performance outcomes and could be adopted as best practices throughout the acquisition community. The authors collaborated with faculty members from other DAU regions

on this research (Tremaine, 2007) and specifically conducted surveys of program offices located at Tank-Automotive and Armaments Command Life Cycle Management Command (TACOM LCMC) in Warren, MI; Air Mobility Command (AMC) at Scott Air Force Base (AFB), IL; and Aeronautical Systems Center (ASC) at Wright-Patterson AFB, OH. The program offices interviewed (Table 1) were recommended by their major commands as having an effective and efficient award or incentive fee program.

TABLE 1. PROGRAM OFFICES INTERVIEWED

ORGANIZATION	PROGRAM OFFICE
TACOM Life Cycle Management Command (LCMC)	Army Future Combat Systems (FCS)
TACOM LCMC	Army Total Integrated Engine Revitalization (TIGER)
TACOM LCMC	Army Biological Detection System
Aeronautical Systems Center (ASC)	B-2 Aircraft-Radar Modernization Program-Frequency Change
ASC	C-17 Aircraft-Sustainment
ASC	F-15 Aircraft-Suite 6 Software Upgrade for A, D, & E Models
ASC	F-16 Aircraft-Operational Flight Program Development
ASC	Global Hawk-Unmanned Aerial Vehicle
Air Mobility Command (AMC)	Global Transportation Network (GTN)
AMC	Air Mobility Command Contractor Tactical Terminal Operations

The research team conducted each survey interview with the program or project manager and contracting officer for the particular program or project. Even though the team did not meet individually with the industry representatives, contractor perspectives were considered an important element of this research.

During midsummer 2006, DAU hosted an Industry Day at Fort Belvoir, VA. Eighteen senior-level industry representatives from throughout the United States came to Fort Belvoir and spoke candidly about their experience with incentive contracts. Table 2 represents a summary of their consensus views.

This article highlights the award and incentive fee findings that resulted in favorable outcomes and examines the innovative use of award and incentive fee, as demonstrated in several acquisition programs.

TABLE 2. SUMMARY OF CONSENSUS VIEWS

1.	Government construction of the award fee plan (including metrics, incentives, etc.) may not link with the offeror's proposed solution or motivations
2.	Industry welcomes the use of base fee to better delineate the difference between "best efforts" (e.g. base fee) and "excellence" (e.g. award fee)
3.	In some cases, the government does not follow its own policies on award fee
4.	On occasion, award fee evaluation criteria are poorly explained or justified and communication of award fee goals and criteria are not clearly explained
5.	It is difficult to establish the relationship between awards for month-to-month activities to the goals of a multiple-year program. The linkage is not always apparent
6.	Administration of award fee criteria can change in post award and create problems during contract execution
7.	Government personnel are not always adequately trained in managing award fee contracts
8.	Post-award administration of award fee contracts is time and resource intensive
9.	Desired outcomes are not always driven by the award fee because of insufficient funds available and subjectivity of the final evaluation
10.	There are sometimes inconsistencies in the timing of the award fee in line with the evaluation criteria
11.	Government and contractors sometimes have different perceptions of the purpose of award fees
12.	In some cases, there is government failure to understand the economics of defense contracting and its impact on government contractors
13.	From time to time, there is inappropriate use of award fee contracts
14.	Requirements are sometimes too subjective and do not measure outcomes that are sought by DoD

FINDINGS

The eight findings presented here are the result of survey data from several program offices and other support material, which allowed the authors to draw conclusions that the information and techniques would help acquisition organizations drive favorable outcomes in their incentive programs. The intention is to have acquisition organizations review all of the findings in a holistic manner to truly drive favorable outcomes.

REGULATORY GUIDANCE RELATING TO INCENTIVE CONTRACTING IS SUFFICIENT

Program managers and contracting officers interviewed supported the view that the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS) were clear and complete. The problem is that in many cases, these regulations are not followed when a specific situation occurs that requires a decision regarding incentive contracting. For example, cost-plus-award-fee (CPAF) contracts certainly have their place in an acquisition professional's tool kit, but FAR 16.405-2(b) states that a "cost-plus-award-fee contract is suitable for use when the work to be performed is such that it is neither feasible nor effective to devise predetermined objective incentive targets applicable to cost, technical performance, or

Fundamental to making a good business decision on which incentive tool will yield the desired behavior is a thorough knowledge of program risk and contract types, and particularly how contract type impacts risk.

schedule" (FAR, April 2008). It also goes on to further define more specific considerations for application. The logic behind the FAR verbiage is that the first choice to be considered is not award fee, but incentive fee using predetermined objective incentive targets applicable to cost, technical performance, or schedule. Given this logic, one could reasonably conclude that the DoD would use more incentives with predetermined objectives rather than award fee in their contracts.

The same logic from the paragraph above applies to fixed-price incentive contracts versus fixed-price contracts with award fee. FAR 16.404(a) states, "award-fee provisions may be used in fixed-price contracts when the government wishes to motivate a contractor and other incentives cannot be used because contractor performance cannot be measured objectively" (FAR, April 2008). Again, given this logic, DoD would use more incentive contracts with predetermined objectives rather than fixed price contracts with award fees.

Fundamental to making a good business decision on which incentive tool will yield the desired behavior is a thorough knowledge of program risk and contract types, and particularly how contract type impacts risk. Part 16 of the FAR has an excellent treatment of contract types. The use of appropriate contract types and associated incentives represents a foundational communication and risk tool for the acquisition professional.

This first finding might lead one to conclude that if award fee requires additional administrative effort, people, and cost, and should only be used when the work to be performed is such that it is neither feasible nor effective to devise objective incentive targets, then why use award fee at all? The answer is there are times when only a subjective incentive will achieve the desired goal or outcome. Subjective measures may be appropriate to drive critical processes, management responsiveness, and other unquantifiable behaviors. In those situations, award fee may be used as long as the expected benefits are sufficient to warrant the additional administrative effort and cost. Due to the complexity and difficulties associated with award fee contracts, most of the findings in the remainder of the article will focus on award fee.

CONSISTENT INCENTIVE PHILOSOPHY

Every government buying activity should have a clearly defined incentive philosophy and broadly communicate that philosophy to its personnel and potential sources. Remember, however, that consistency and flexibility are not mutually exclusive. A consistent incentive policy can and should provide flexibility to arrive at an appropriate incentive strategy that suits the circumstances of each contract action. This may cause one to use multiple incentive types, as is occurring in many successful incentive programs.

Use the contract and incentive plan to communicate the philosophy and overall mission objectives to the contractor. The result will be consistent communication between the buying activity and the contractor community.

MULTIPLE INCENTIVE-TYPE CONTRACTS—BUILD TO NEED

According to the majority of organizations interviewed, the combination of objective and subjective measures indicated the strongest correlation to expected outcomes. The subjective measures were only used when objective measures alone would not achieve the desired outcome to the same level.

BASE FEE—AN INTEGRAL PART OF COST-PLUS-AWARD-FEE CONTRACTS

The research team found that organizations that were successfully implementing CPAF understood the purpose and value of using a base fee as a leverage tool for the proper use of the award fee portion of CPAF. The DFARS 216.405-2(c) (iii) currently states, “the base fee shall not exceed 3 percent of the estimated cost of the contract exclusive of fee” (DFARS, July 2006).

Using a base fee allows the government to reward the contractor’s “best efforts” without compromising the intent of the award fee portion. In a scenario where the contract calls for no base fee, contractors could provide their best efforts for the

award fee period and receive no fee if they did not achieve "excellent" performance. Best efforts refers to the contractor's responsibility to meet the contract requirements under the terms of the contract. When no base fee is provided in the contract, it puts pressure on the government to provide some portion of the award fee for best efforts. This opens the door to more administratively burdensome measures like the 2003 rule in DFARS 216.405-2(b)(3) that permits provisional award fee payments. Properly using base fee could alleviate the need for provisional award fee payments. When a portion of the award fee is paid for best efforts, it opens the government to criticism by oversight agencies for providing award fee for less-than-excellent performance.

When no base fee is provided in the contract, it puts pressure on the government to provide some portion of the award fee for best efforts.

If a base fee is in the CPAF contract, the contractor will receive some amount above costs for best efforts. For example, the F-15 Systems Program Office (SPO) communicated with the contractor that they were only going to pay award fee for excellence, and in their deliberations the contractor asked for a 3 percent base fee. The F-15 SPO agreed with the contractor, the logic being that it would provide the SPO the leverage they needed to only pay the award fee portion for excellent performance. To further explain the leverage aspect of the base fee in a CPAF contract, the base fee should be paid regardless of performance on the contract as long as the contract is not terminated. On government cost reimbursement-type contracts, the actual payment of a base fee typically accompanies a contractor's regular invoice for reimbursement of costs.

Other programs that have used CPAF successfully appear to be recognizing the value of using a base fee. To distinguish excellent performance from best efforts, the Global Hawk SPO revised their contract to include a 3 percent base fee.

The defense contractors interviewed at Fort Belvoir agreed in principle that in CPAF contracts, some amount of base fee for their best efforts would more clearly delineate the difference between payment for best efforts and payment for excellent performance (award fee), thereby reducing the criticism concerning the use of award fee contracts.

EVALUATION PERIODS—LINKAGE IS KEY

One common data point for determining evaluation periods is linkage to significant events. Using events or outcomes to determine award fee periods instead of time ensures that the award fee period will be appropriate to the events or outcomes. When award fee is based on time, there is an assumption of what events or outcomes will occur in that time period; and that assumption also drives the amount of award fee for

the period. In complex contracts, schedules often slip, so if the award fee period is based on time, and a significant event or outcome slips to another award fee period, the government could have an inappropriate amount of award fee available for the wrong reasons, thus not achieving the objectives of the award fee plan.

Examples of evaluation periods linked to significant events are: (a) The F-15 program tied the award fee periods to program milestones so the award fee periods varied from 6 to 9 months depending on when the milestones were reached; (b) Global Hawk added alignment with the contractor's fiscal year; and (c) Both the Army's Future Combat Systems and Total Integrated Engine Revitalization Program used cost-plus-fixed-fee (CPFF) contracts with incentive events.

The events were tied to contract outcomes and varied with each period. These examples clearly indicate that when possible, evaluation periods should be linked to events or outcomes rather than time.

FEEDBACK—SHOULD BE FREQUENT AND UNAMBIGUOUS

Feedback in incentive contracting is important, particularly in contracts with an award fee element because they require so much administration. The administrative burden can seem to be bureaucratic and excessive. However, the research results showed that monthly feedback within the joint government and contractor team was more effective than quarterly or biannual feedback. Continuous and open dialogue at both junior and senior levels led to early discovery and timely reconciliation of many known issues and helped keep the program on track. Many program offices empha-

Continuous and open dialogue...led to early discovery and timely reconciliation of many known issues and helped keep the program on track.

sized that they were very open with the contractor; therefore, the contractor was never surprised. Additionally, some programs instituted certain techniques like "emphasis letters" during the award fee periods to stress the importance of certain outcomes or events. One particular program office employed what they called a "barometer report" during interim reviews to ensure that information from monitors was readily available to manage at critical junctures.

Several program offices found it necessary to establish a glossary, particularly for terms related to critical outcomes or events in incentives. The glossary was used as a tool to improve communication during the evaluation briefings. Glossaries were also beneficial when team member changes occurred. A good example for the use of glossaries occurred in the B-2 SPO on the Radar Modernization Program–Frequency Change contract. The program was in the systems development and demonstration

(SDD) phase, and there was a requirement in the contract that the radar make first flight to demonstrate success. The government understood first flight to mean aboard an aircraft and demonstrating functionality. The contractor understood a successful first flight to be only aboard an aircraft. They never intended the radar to demonstrate functionality on first flight. Contracts that include incentives must be unambiguous, and glossaries are a good tool to prevent misunderstandings.

CONDUCT TRAINING AND USE EXPERIENCED PERSONNEL

Nothing seems to have a more dramatic impact in DoD than training and experience. One learns from successes and failures in the field, and then makes adjustments. Incentive-type contracts are no different. Many of the program offices responding to the survey incorporated the practical incentive/award fee experience of personnel already embedded in their organizations. Other program offices formalized instructions while continuing to coach personnel on the use of incentives. Several program offices suggested that the most effective training is just-in-time training with the entire incentive team attending. They emphasized that the entire team includes the monitors,

Training as a team is essential to success.

program managers, procuring contracting officers, board members, fee determining official, and the administrative contracting officer, if applicable. Some program offices suggested that performance monitors observe how other program offices conduct assessments to help them appreciate the depth of evaluations. The interview surveys clearly lead to the conclusion that each program office must develop its own unique, just-in-time incentive training based on the incentives in the acquisition and the experience of the acquisition team. Depending on the experience of the team, it may be necessary to obtain assistance from other program offices or training organizations such as the DAU. Training as a team is essential to success.

ROLLOVER—ANOTHER INCENTIVE TOOL

Unearned award or incentive-based fees may be carried forward for possible award in subsequent evaluation periods; however, this process should be the exception and not the rule. The vast majority of the program offices surveyed expressed caution and noted that they either used rollover judiciously or not at all. Rollover has certain disadvantages regardless of how or when it is used: it devalues previous periods and it allows contractors to lower performance in some periods without consequences (Garrett & Gilbreth, 1992).

In certain limited situations, rollover may be appropriate where circumstances beyond the control of the contractor prevent excellence in performance or where

the government wishes to motivate excellent performance in subsequent award fee periods. An example of the latter could be maximizing the incentive for the contractor by allowing rollover on pre-flight testing when the successful launch of a satellite is the government's ultimate goal.

REALISTIC INCENTIVE STRATEGIES—PATHWAY TO SUCCESS

As described in the findings, the research team visited many acquisition organizations that used specific techniques to drive favorable outcomes. This section highlights several acquisition organizations that are using incentive strategies tailored to relate very well to their desired contractual outcomes. This research demonstrated that one size or type of incentive strategy does not fit all situations or outcomes. While the research team could have used examples from many other acquisition organizations, the variety and types of incentives and outcomes were key in these selections.

AIR MOBILITY COMMAND (AMC) CONTRACTED COMMERCIAL GATEWAY SERVICES AT BALTIMORE–WASHINGTON INTERNATIONAL AIRPORT

The contract is a fixed-price-award-fee (FPAF) services contract for passenger handling at $1 million per year for 5 years. At first glance, many acquisition professionals would say they do not like award fee on fixed-price contracts, but AMC thought otherwise. According to the contracting officer:

> We use an award fee for the Commercial Gateway at Baltimore because this contract provides a very customer-focused service. The contract spells out the requirements needed; however, there is much more the contractor can provide to ease the stress of our travelers. We all recognize good customer service when we see it, but it is difficult to put in writing. As various situations arise, it is very beneficial to have a contractor who recognizes ways they can assist and has the initiative and authority to step up and do so.[1]

The goal of the program office in using award fee was to motivate the contractor to provide the military with the best commercial air service possible. The award fee earned by the contractor is determined at the completion of two award fee periods per year, but performance monitors submit their evaluation reports to the Functional Director (FD) every month. Reports fully document the contractor's performance during the period. An overall rating of excellent, very good, good, satisfactory, or unsatisfactory is assessed on each completed report to the FD. In addition to the reports, performance monitors collect all observations (e.g., customer complaints/surveys, etc.) and submit them to the FD every month. All reports/performance indicators are consolidated by the FD into a performance report and submitted to the contracting officer with a recommended rating. These reports are then forwarded to the contractor within 20 days after the close of each month. In making its recommendation, the Award Fee Review Board considers both the FD's report as well as the contractor's presentation.

The contractor was evaluated on four categories: customer service, passenger service, baggage service, and management. The categories were weighted evenly because the contractor needed to perform equally well in all categories. The award fee plan provided for no earned award fee for unsatisfactory performance. Additionally, the plan provided no award fee for satisfactory performance (meeting the terms and conditions of the contract). The rationale is that the profit inherent in the fixed-priced contract rewards the contractor for satisfactory performance.

This fixed-price award fee contract has been very successful and achieved favorable outcomes.

Both the program manager and contracting officer stated that the award fee was very effective at motivating the contractor, and this was validated by customer surveys. They also felt that objective criteria would not achieve the level of favorable outcomes that they have achieved with award fee. This fixed-price award fee contract has been very successful and achieved favorable outcomes. Customer surveys support that conclusion.

TACOM LIFE CYCLE MANAGEMENT COMMAND, FUTURE COMBAT SYSTEMS (FCS)

The FCS is the Army's new generation of manned and unmanned ground vehicles, air vehicles, and munitions, each of which taps into a secure network of superior combat information. These weapons systems are designed to be a fraction of the weight of current weapons, but are just as lethal and survivable.

The SDD contract is an innovative CPFF contract with incentive. The current fee arrangement includes a 7.5 percent fixed fee and a 7.5 percent incentive fee component. The incentive fee clause in the contract states:

> The key objectives of the SDD program are to prove out technologies and systems integration and to move the program forward into readiness for initial production, at an affordable cost and on schedule. The purpose of the incentive fee is to encourage and motivate the contractor to place the program in an appropriate risk position. To this end the government desires to incentivize the contractor for successfully meeting these objectives within certain performance, cost, and schedule constraints.[2]

The cost constraints are comprised of Life Cycle Cost Containment (LCCC) and Average Unit Procurement Cost (AUPC). The incentive fee is focused on the performance of selected program events. The SDD contract includes nine incentive

events with four or five sub-criteria defined for each event. The events and sub-events associated with performance elements are defined in the Integrated Master Plan (IMP); the events and sub-events pertaining to the schedule elements are based on the Program Event/Milestone thresholds in the Acquisition Program Baseline (APB) or on the Integrated Master Schedule. The assessment and the percentage allocation of the available incentive fee are determined by mutual agreement of the government and contractor, and are incorporated into the contract clause at least one incentive event prior to the event under consideration. This continuous dialogue allows the government and contractor to reassess the criteria and determine if the weightings still have merit as written or should be altered, and if additional criteria should be added. In those cases where no incentive fee allocation is set for a specific event, a default allocation is applicable.

The incentive categories selected for the FCS SDD contract were designed to insure that the program office could afford to produce the items developed in SDD. The CPFF with Incentive strategy is very effective in motivating the contractor: the contractor is meeting cost and schedule objectives; technical performance is successfully proceeding as the first prototype nears delivery; and the Army is pleased with the contractor's performance.

TACOM LIFE CYCLE MANAGEMENT COMMAND, TOTAL INTEGRATED ENGINE REVITALIZATION (TIGER) PROGRAM

The TIGER program is an Army initiative to revitalize the Automotive Gas Turbine (AGT) 1500 engine fleet that supports the Abrams Tank and derivative vehicles—the M1A1 tank, M1A2 tank, System Enhancement Package (SEP) tank, and the Heavy Assault Bridge (HAB). The TIGER program will increase the reliability of the AGT 1500 engine by improving the overhaul processes to a near new engine standard, including durability-based design improvements, and will provide the support to Anniston Army Depot (ANAD) for the overhaul of approximately 1,060 AGT 1500 engines per year.

The contractor's performance is measured by four metrics: Engine Availability, Durability, Cost, and Small Business Participation.

The contract is fixed-price with an incentive fee consisting of a Program Year Transition (PYT) and PY 1 through PY 3 determinations. A unique aspect of the contract is that the incentive metrics are objective as one would expect, but also included therein are attributes similar to award fee such as having a review board and fee determining official. The board meets annually to evaluate and validate the

contractor's performance. The contractor's performance is measured by four metrics: Engine Availability, Durability, Cost, and Small Business Participation. In each program year, the amount of the fee pool and the weights assigned to the four incentive metrics are determined based on the events of the particular program year. These metrics are considered to be of key importance in achieving the overall performance goal, which is to improve the mean time between depot return (MTBDR) from the current 700 hours to 1,400 hours at a reasonable cost by the end of PY 3.

In each program year, the contractor will be challenged to exceed the government threshold. If contractor performance is considered satisfactory, the contractor will not receive any incentive fee. In other words, incentive fee is only paid for exceeding the threshold/satisfactory performance level.

Using a fixed-price contract with incentives that also allows rollover...may be necessary to achieve success.

This incentive approach is tied directly to the metrics creating a strong link to favorable outcomes. Additionally, incentive funds not earned for a period may remain in the incentive fee pool as rollover. The program office is judiciously using the rollover incentive funds and realizes that the contractor still has to earn all incentive fee payouts.

As can be seen, this incentive strategy is a highly leveraged construct that requires the achievement of many goals designed to enable the contractor to reach the overall performance goal of 1,400 hours MTBDR within specific cost objectives. Using a fixed- price contract with incentives that also allows rollover is certainly a challenging strategy for the contractor to meet, but it may be necessary to achieve success. Whether the contractor will meet cost, schedule, and performance incentive parameters is too early to tell, but the Army's communicative and innovative approach makes success much more likely.

AERONAUTICAL SYSTEMS CENTER (ASC), F-15 AIRCRAFT SUITE 6 SOFTWARE UPGRADE FOR A-E MODELS

The F-15 Aero Systems Group uses a unique CPAF contract to perform this effort. While a typical CPAF contract uses only subjective criteria, the F-15 Aero Systems Group used both objective and subjective criteria as they deemed appropriate. They used government-contractor integrated process team (IPT) sessions to establish the criteria used in the award fee periods, which has been very successful. Each award fee period is tied to key deliverables and has preplanned adjustments. In the first award fee period, cost and schedule were weighted more heavily than the other criteria. Cost and schedule were each weighted at 30 percent, and program management and subcontract management were each weighted at 20 percent. The subjective evaluation

criteria are program management and subcontract management. The program office created a strong link to favorable outcomes and reduced program risk by developing the award fee objectives and linking the award fee periods to key deliverables.

It is interesting to note that the contractor initially preferred an award fee with only subjective criteria, and expressed concern at the use of objective criteria. However, when the program office structured a base fee of 3 percent, the contractor accepted the government's plan. This demonstrates how the base fee can be leveraged, thereby requiring excellent performance to receive the "award portion" of award fee.

Each of the four example programs cited here was quite different, but they used specific incentive strategies that related very well to their desired contractual outcomes.

This CPAF contract is still in the early stages of performance; however, the use of the IPT in developing the award fee objectives, linking the award fee periods to key deliverables, and leveraging the base fee by only awarding the award portion of award fee for excellent performance, should provide a solid foundation for successful contract performance.

Each of the four example programs cited here was quite different, but they used specific incentive strategies that related very well to their desired contractual outcomes.

RECOMMENDATIONS AND TAKE-AWAYS

INCENTIVE PHILOSOPHY

Every government buying activity/command should have a clearly defined incentive philosophy that is consistent with the FAR, DFARS, and Service/Agency policy. This incentive philosophy should be clearly communicated to all personnel and potential contractor sources.

TRAINING

The amount of training depends on the team's experience. Experienced teams may only need refresher type training (e.g., Phase 3 below). Inexperienced teams should consider a three-phased approach to training. The first phase is a comprehensive core block of instruction on incentive contracting for Defense Acquisition Workforce Improvement Act (DAWIA) Level II business and technical personnel. This provides a basic body of business and acquisition knowledge for the individual acquisition members. The second phase is just-in-time training using a continuous learning module on incentives. The third phase is lessons learned on a community of

practice (COP) or by classroom teaching from within or by an institution such as the DAU. Once the required amount of training is determined, the authors recommend that the entire acquisition team should participate in Phase 3 together. This develops teamwork in the learning process, which benefits the acquisition team.

FEEDBACK

Cost-plus-award-fee and other incentive-type contracts provide contractors with numerous avenues to communicate openly with the government during contract performance. Moreover, incentive contracts provide the government with greater input or leverage to motivate contractors to achieve exceptional performance. More specifically, the authors recommend that program offices document in their contracting file the use of any subjective incentives, rollover features, incentive ratings, creative approaches to incentivizing, and any exceptions to policy. Documentation or approvals required to take a certain specialized acquisition approach should never discourage one from being innovative, if the business acumen supports such an approach. The authors also recommend that program offices create a glossary of terms, particularly terms related to critical outcomes or events. This will prevent misunderstanding between the program office and the contractor in the evaluation of incentives, and also prove helpful for personnel who are new to the program office and its associated terminology.

AWARD FEE

When an acquisition tool comes under scrutiny, the tendency is to avoid it. This has occurred with award fee contracts. Invariably, in certain circumstances only a subjective incentive will achieve the desired goal or outcome. However, award fee should be used only when performance cannot be determined objectively. The contract file should clearly communicate the rationale and decision to use award fee. This may result in a multiple incentive-type contract containing both incentive and award fee clauses. This is consistent with new guidance provided by memorandum from the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (OUSD[AT&L] Memorandum, April 2007). The following recommendations relate primarily to award fee:

Base Fee. Use base fee in CPAF contracts. It provides the necessary leverage for the proper use of the award portion of CPAF. The DFARS (216.405-2(c) (iii)) currently has a limit of 3 percent on base fee. Consider requesting a deviation to the DFARS to increase the base fee percentage and make better use of base fee as a leverage tool.

Evaluation Periods. Set the award fee periods based on events or outcomes rather than based on time. This will ensure that the award fee will be appropriate for the work accomplished within the period.

Relate Fees to Outcomes. The percentage of the fee pool for the award portion of the award fee should be commensurate with the importance of the outcomes for that award fee period.

Rollover. Rollover should seldom be used, but in certain limited situations the advantages to the government of using rollover outweigh the disadvantages. Weigh this decision carefully and always document the rationale.

CONCLUSIONS

When it comes to incentives, evaluate all options. As shown in the four examples in this article, one size does not fit all situations. In the early stages of acquisition planning, seek help from experienced acquisition professionals in the organization or from the DAU faculty who have experience in the use of incentive contracting and developing incentive strategies. These experienced professionals can also be very helpful by conducting real-time training and providing facilitation for the acquisition team. Use Defense Contract Management Agency (DCMA) support through the FAR delegation process; DCMA can serve as a valuable asset for evaluating contractor performance. Seek cost estimating and pricing support. In the acquisition planning phase, build the team and gather market research information. This will enable an accurate determination of risk necessary for determining contract type and will help in the structuring of logical and effective incentives tailored to the program. Developing effective and efficient award and incentive fee programs is truly a team effort.

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ENDNOTES

1. Commercial Gateway Baltimore contracting officer's E-mail response, January 11, 2007, to research team interview/follow-up question.

2. Incentive Fee Clause excerpted from U.S. Army TACOM Life Cycle Management Command Contract W56HZV-05-C-0724, System Development and Demonstration issued in 2005.

Image designed by Harambee Dennis

PPBE: A RED OR A BLUE PILL? CAN DEFENSE SENSEMAKERS REALLY BE RATIONAL IN A HYPERTURBULENT WORLD?

COL Christopher R. Paparone, USA (Ret.)

The author applies social construction theory to reveal potential blind spots associated with the technical rationality paradigm rooted in the Defense Department's Planning, Programming, Budgeting and Execution (PPBE) process. Drawing heavily on Karl E. Weick's (1995) version of sensemaking (i.e., using, modifying, rejecting, and creating new paradigms or shared mental models when dealing with situations of incoherency and disorderliness), this article reveals the paradoxical qualities along three socially constructed schemes: the Pentagon world of PPBE, the world of political reasoning, and the hyperturbulent world described as our contemporary operating environment (COE). Ultimately, the author argues that Defense resource management professionals could be living in a dream world not unlike that imagined by the character, Neo, in the popular movie, *The Matrix*©.

"Rationality, of course, is a moot issue when causality is poorly understood."

—Russ Marion, The Edge of Organization

For almost half a century, the Department of Defense (DoD) has enjoyed the reputation of being accountable and responsive to both the Executive Branch and Congress by presenting rational solutions to well-defined requirements. The DoD's Planning, Programming, Budgeting and Execution process (PPBE for short) has evolved into one of the most sophisticated and regimented examples of comprehensive strategic planning in the world (Roberts, 2000; McCaffrey & Jones, 2005).

However, the efficacy of the strategic planning paradigm as a method for allocating resources (e.g., Gulick, 1937; Ansoff, 1979; Bryson, 1995; Kaplan & Norton, 1996; Lewis, Brown, & Schrader, 1999) has been under considerable attack for decades (e.g., Lindblom, 1959; Allison, 1969; Mosher, 1969, Rittel & Webber, 1973; Steinbruner, 1974; Senge, 1990; Mintzberg, 1994; Kingdon, 1995; Michael, 1997; Stone, 1997; Downs, Durant & Carr, 2003). This article addresses this dichotomy by presenting the case for higher order sensemaking—shorthand for the phenomenological view[1] of how human beings can purposefully use, modify, reject, create, and share paradigms when dealing with complex or chaotic situations.

This is an argument for sensemaking, centering the discussion on transforming how to think about managing DoD resources. It highlights the limits of technical rationality (the philosophical basis of PPBE), the logic of political reasoning, and the complexities of the contemporary operating environment (COE). The phenomenological proposition is that by presenting thoughts about collaborative inquiry from a social constructionist perspective, DoD professionals (both civil servants and military officers) and their clients (political appointees or elected officials) can make better shared sense of managing resources under complex and chaotic conditions.[2]

SENSEMAKING WITHIN THE PPBE CONTEXT

The modern concept of rationality is a relatively new one in the scheme of world history. René Descartes (1596–1650) was an important framer of the enlightenment associated with the idea that the world can be objectified through the emerging positivist philosophy of Newtonian science.[3] The central idea of scientific (or technical) rationality is that objectivity can be verified with the content of a positivistic body of knowledge (Hacking, 1982). Recently, post-Newtonian scientists (i.e. postpositivists) have challenged the Cartesian assumptions associated with the belief in objective reality—that the world is separate from us and our conceptualizations of it (e.g., Weick, 1995; Hatch, 1997; Kilduff & Mehra, 1997; Whipp, 1999). The common sense (prevalent social-psychological disposition) associated with René Descartes' *I think therefore I am*, is replaced with the less common sensemaking premise of, *I think therefore I imagine.*

Sensemaking, a form of imagination, is characterized by individuals and groups using, modifying, rejecting, and creating new paradigms or mental models when dealing with situations of incoherency and disorderliness (Weick, 1995). Sensibility is about reaching a condition of open receptiveness to emergent and sometimes counterintuitive and countercultural mindfulness as contrasted with a taken-for-granted mindlessness. The idea of mindfulness is oriented on being wholly engaged in scrutiny, a continuous refinement of expectations based on new experiences, and a willingness to invent new expectations (Weick, 1998). For example, the positivist-based assumptions of strategic planning include a belief that predicting pathways to achieving goals will bring certain finality to solving problems. Incommensurate with that logic, sensemaking implies there is no finality because humans socially construct a reality that they can never be certain about (Berger & Luckmann, 1967; Searle,

1995). The challenge in sensemaking is to treat experience and prior learning repositories (such as planning habits, doctrines, and rules) as theories for action that should be tried and tested continuously in search of new mental models (Argyris and Schön, 1978).

This phenomenological approach allows us to step back in a metaphysical way to examine the Pentagon-created world of PPBE.[4] As such, PPBE (based in the logical positivism of operations research and systems analysis) has become something akin to a cultural ideology in the DoD; witness where alternative types of decision making are disdainful if not incomprehensible (Paparone & Crupi, 2006). This ideology reflects an unquestioned belief, especially in numeric values or metrics, associated with an isolatable, predictable, and reproducibly testable cause- (ways and means) and-effect (ends) relationships. The rational discovery of these ends, ways, and means

***The common sense (prevalent social-psychological disposition) associated with René Descartes'* I think therefore I am, *is replaced with the less common sensemaking premise of,* I think therefore I imagine.**

through technical processes is believed to be unbiased by emotions and unaffected by unethical political, cultural, and psychological values that would otherwise distort the results (Simon, 1997). Although the process has evolved to be a very complicated series of planned events and documentation, PPBE is essentially rooted in the sequential steps of the generic rational decision-making process, borrowed from the modern scientific method of hypothesis testing: (a) Define the problem (reducing the complicated to a manageable dependent variable); (b) present all facts and assumptions bearing on the problem (what affects the variable); (c) develop courses of action (COA) to solve the problem (search for the independent variable); (d) select the best COA based on objective criteria for analyses (how to make the independent variable more powerful in a reproducible way); and, (e) implement and provide feedback (analyze the results and report in preparation for the next cycle). This paradigm assumes problems can be defined in relative independence from other conditions through a process called reductionism. For example, in the DoD's force management, the current practice is to reduce and categorize problems (treated as dependent variables) and associate them with potential funding of programmatic solutions in doctrine, organization, training, materiel, leadership, personnel, and facilities (the DoD's list of standing independent variables). The fundamental belief is that the outcome of PPBE serves to argue, in a sterile sort of way, the case for obtaining and using public resources. In addition, through the PPBE lens, managers assume that problems of

defense are relatively stable and will generally be the same problems defined now as when they are eventually "solved" five or more years from now.

Other assumptions presuppose that there is no better way to control spending from the perspective of those appointed as publicly responsible and accountable at the top of the governmental hierarchy; that the President and Congress unconditionally expect the DoD to propose the most efficient single course of action for spending; and that the PPBE approach is the most influential way to obtain and use resources in our system of government. These assumptions are as ingrained into the fabric of the DoD culture as to be considered by its members to be tacit knowledge (Polyani, 1966).

From the postpositivist perspective, at least three issues with these beliefs are set forth in the PPBE paradigm:

- PPBE creates myopic learning. Plans, programs, and budgets spawn specified expectations; hence, blind managers who overly focus on confirming predictions rather than preoccupying themselves and their organizations with updating their thinking especially in light of an uncertain environment.
- PPBE undercuts organizational creativity and improvisation. Although plans, programs, and budgets seem to provide some contingent actions (i.e., plans for branches and sequels) based on present views of required capability, managers shun forms of adhocracy to deal with the unexpected; whereas, adhocracy may serve them and their clients better in some cases than institutionalized solutions.
- PPBE fosters "mindless" decision traps. Regulatory approaches to budgeting activities make even the smartest managers prone to repeat patterns of action that have worked in the past (a form of mindlessness); rather, being mindful of the uniqueness of situations that makes the pursuit of best practices or benchmarks seem dangerous.

In contrast to the mental confines of strategic planning, continuous sensemaking demands being mindful, and both appreciating that something needs to be done and changing what to do. It demands the recognition that ends, ways, and means are transitory and will morph over time as political interpretations and environmental conditions change. It acknowledges that this process is interactive—the environment is affected by what is done and that the environment will reciprocate—in a never ending dynamic of interactive, mutually causal variables (Weick & Sutcliffe, 2001).

SENSEMAKING WITH POLITICAL MINDFULNESS

The paradigm associated with political reasoning is often difficult to discern from presumed technically rational approaches (such as PPBE) because the process is often intentionally or perhaps subconsciously masked by the appearance of unequivocal results of analyses. With political reasoning, however, there can be no set linear programming steps; albeit, politicians, political appointees, and their constituents may believe or give the appearance that they are one and the same (Stone, 1999). The nature of political reasoning may include distinctive qualities such as: use of equivo-

cation; presenting (or hiding) multiple and convenient interpretations of the same rules, policies, and laws; undemocratic forms of agenda setting; purposeful exclusion of decision participants; deceptive bargaining and "logrolling"; guile; blending alternatives that appear dichotomous; satisfying the interests of only the most powerful constituencies while trying to appear to satisfy weaker and voiceless minorities; taking special interest benefits; storytelling to frame or spin how the problem should be defined; exploiting dogmatic or popular beliefs in a causal chain of events; advocating already thought of solutions by purposefully attaching them to emergent problems; and using institutionally biased values that drive course of action selection criteria.[5]

In contrast to the mental confines of strategic planning, continuous sensemaking demands being mindful, and both appreciating that something needs to be done and changing what to do.

Implied by commentary on political leadership, that "you can fool some of the people…" (Abraham Lincoln, 16th president of the United States), when DoD resource management professionals who believe strongly in the virtue of technical rationality discover that the political form of reasoning is not adhering to their expectations, they can become cynical, distrusting, and may lose their ability to dialogue honestly with their clients (Schön, 1983). On the other hand, when the political reasoning process appears to produce a desirable outcome, observers who make sense of the world through the lens of technical rationality can also falsely attribute positive results to policy decisions made by the client; albeit, there may be compelling evidence that the outcome was random—simply a matter of serendipity (Meindl, Ehrlich & Dukerich, 1984; Kingdon, 1995). Marion (1999) describes this attribution phenomenon in terms of a ritual where "strategic planning can provide leadership with an opportunity to reinforce its position in the pecking order. It is a statement that says management—like the shaman at primitive rain dances—is potent and in control" (p. 219).

With regard to both scenarios, DoD resource professionals could view their clients as those who exploit them, either for purposes of blame when their PPBE analyses are taken and appear to fail or when the results of the PPBE process are not listened to, and yet the outcome is favorable. Yet, if both parties were to agree that the outcome was more random than predictable with respect to the mutual causality inherent to environmental conditions, then the ensuing dialogue might be more open, honest, and insightful (Schön, 1983). Some evidence of this inability to plan and program budgets over the long term can more readily be understood using a chess metaphor.

Episodic strategic planning under complex conditions is analogous to trying to play chess with all the moves planned out in advance. Modelers of complexity have calculated that there are 10^{120} possible variations in chess moves possible in a single game. Mitchell Waldrop in his 1992 book, *Complexity*, suggests this "was a number so vast [as] to defy all metaphor. There haven't been that many microseconds since the Big Bang" (p. 151). He goes on to say, "We human players have to make do with rules of thumb—hard learned heuristic guides that tell us what kind of strategies will work best in a given situation" (p. 151). John H. Holland, in his 1998 book *Emergence*, discusses the extraordinary complexity of chess.

> Chess … has enough emergent properties that [it] continues to intrigue us and offer new discoveries after centuries of study. And it is not just the sheer number of possibilities. There are lines of play and regularities that continue to emerge after years of study, enough so that a master of this century would handily beat a master of the previous century (p. 23).

The point is that chess, with only a dozen or so rules, creates extraordinary complexity that defies prediction. In much more complex situations involving national defense, how can planners expect to map strategies when the "rules" not only are difficult to discern, but which change dynamically in a short period of time? To substantiate this doubt, have Defense planners gone back to historic plans to judge how accurately past objectives met the needs of the future?

Episodic strategic planning under complex conditions is analogous to trying to play chess with all the moves planned out in advance.

The 1993 *Report of the Bottom-Up Review* (the precursor to the quadrennial review process) had only one force structure counter-terrorism task envisioned during "peace enforcement and intervention operations." The task was too vague to tie to any specific program or budget: "securing protected zones from internal threats, such as snipers, terrorist attacks, or sabotage" (Aspin, 1993, p. 47). A later example includes the 1997 *U.S. National Security Strategy for a New Century*. This plan had a section on transnational threats that grouped terrorism along with drug trafficking and international crime. Counter-terrorism goals were addressed in the following sentence (parenthetical alphabetical letters represent emphases added):

> Our policy to counter international terrorists rests on the following principles: (a) make no concessions to terrorists; (b) bring all pressure to bear on all state sponsors of terrorism; (c) fully exploit all available legal mechanisms to punish international terrorists; and (d) help other governments improve their capabilities to combat terrorism (Clinton, 1997, p. 14).

Conspicuously absent in this historic plan is the need to prosecute a global war on terror of the magnitude the United States is engaged in today. Finally, the now defunct *Joint Vision 2020*, published in June 2000, focused on a force protection, antiterrorism goal without mention of a major DoD comprehensive role in combating terrorism in an offensive way. One could conclude that these strategy documents hardly guided creation and acquisition of DoD capabilities to counter terrorism; and, with the advantage of hindsight, they were insufficiently visionary to mobilize the military toward a global war on terror that emerged within the future year defense planning window. Also important to note is that none of these documents made mention of foreseeable military operations that would include the need for military support for stability, security, transition, and reconstruction operations. The issue is not the quality of the planning process; rather, it is the belief that the strategy-making process can predict the future with any reasonable certainty. The entire PPBE process is based upon that belief. Unfortunately, environment is not cooperating with these linear expressions of causality.

SHARED MINDFULNESS OF THE CONTEMPORARY OPERATING ENVIRONMENT

The COE is best described as hyperturbulent and characterized by the velocity and degree to which patterns of otherwise quasi-stable environmental changes are shifted to unstable, maladaptive patterns (McCann & Selsky, 1997). One convincing paradigm that acknowledges the complexity of sensemaking in the midst of the disorder and chaos associated with hyperturbulence is Rittel's and Webber's (1973) theory of wicked problems (similarly described as "messes" by Ackoff (1999, p. 178). According to these observers, "Social problems are never solved … at best they are only re-solved—over and over again" (1973, p. 160). I paraphrase and interpret Rittel's and Webber's distinguishing properties of wicked problems as follows:

- ***No definitive formulation.*** This includes the recognition that complex problems are ill-defined and/or that more information does not make the problem less ambiguous.
- ***No stopping rule.*** That is, past solutions or best practices may continue even if conditions change, and the conditions of the problem change more rapidly than a planned, programmed, or budgeted change can keep up with; hence, the solution becomes disconnected from the problem as the problem morphs. Finally, turnover and fluidity of participants in the affected organizations or institutions further confound the process.

- ***Not true or false, but bad or good solutions.*** Solutions are politically, culturally, and psychologically charged, that is, they are infused with the sometimes hidden values of those in power or with influence; hence, unseen values judgments and intuition—not economic reasoning—can and will dominate.
- ***No immediate or ultimate test for unintended consequences.*** Because the situation is so complex, with variables that exhibit the dynamics of mutual causality, no one or no group can predict what will happen. The future years defense plan approach will likely be fraught with "type III error" (Mitroff & Kilmann, 1981)—unknowingly solving the wrong problem with precision.
- ***May have one shot only because of irreversible consequences.*** Even if the manager acts in committing resources to a single course of action, the dynamics of taking action itself will change the environment and the previous conditions will be irretrievable.
- ***No enumerable or exhaustive set of solutions.*** Courses of action can seem like bad or worse, or the lesser of two evils, or may even be incomprehensible—military planners metaphorically call this phenomenon the solving world hunger kind of impossible challenge, not unlike the intractable messes associated with prosecuting "irregular" warfare with conventional analytical models associated with the military decision-making process.
- ***Uniqueness.*** Restated, it is hard or impossible to find benchmarks or best practices from the past or other examples of success, historic anecdotes, doctrine, or documented lessons learned.
- ***Probably a symptom of another problem.*** There is no single problem but a systemic network of interactive and interdependent problems that is too complex to unravel.
- ***Discrepancy.*** The conceived gaps between ideal end and where managers perceive things are can be explained in numerous ways, and there is no systematic procedure to get to the right answer. This quality makes Cartesian solutions fruitless but gives political actors opportunity for framing a façade of technical rationality to convince voters to elect them.
- ***The planner, programmer, or budgeter has no right to be wrong.*** Albeit, they deal constantly with the reality of a large, complex adaptive system—or organized anarchy (Cohen, March, & Olson, 1972)—that experiences forever dynamic and unpredictable trajectories, fraught with ambiguity, and complex causal webs that defy the articulation of a desired end state or strategic objective (1973, pp. 161–166).

The process of sensemaking reveals that the nature of the COE is not something managers have to deal with as external to their daily lives and the routine workings of the DoD. Indeed, managers and their organizations are both in it and interact within the interconnected workings of it in a dynamic, never-ending way. It is implausible, if not impossible, to isolate the world of PPBE against the backdrop of the hyperturbulent environment and the intervening world of the political players. This is

reminiscent of the storyline in the 1999 movie, *The Matrix*, where the main character, Neo, must make sense under paradoxical worldviews represented by a blue or red pill (Wachowski & Wachowski, 1999). If Neo takes the blue pill, he accepts the well-ordered world to which he is accustomed, unaware that he is asleep and that his psyche is being fed by a computer program (called the Matrix). However, if he takes the red pill it will mean facing a deeper meaning of reality that may be shockingly unpleasant to accept. He would no longer be isolated from the harsh reality that the world is really a very messy place, ridden with surprises, death, and destruction. Neo chose the harsher, more uncomfortable reality and ultimately led his followers to emancipation through revolution (metaphorically, a transformation that overthrew the technically rational world view provided by the Matrix).

Social problems are never solved…at best they are only resolved—over and over again.

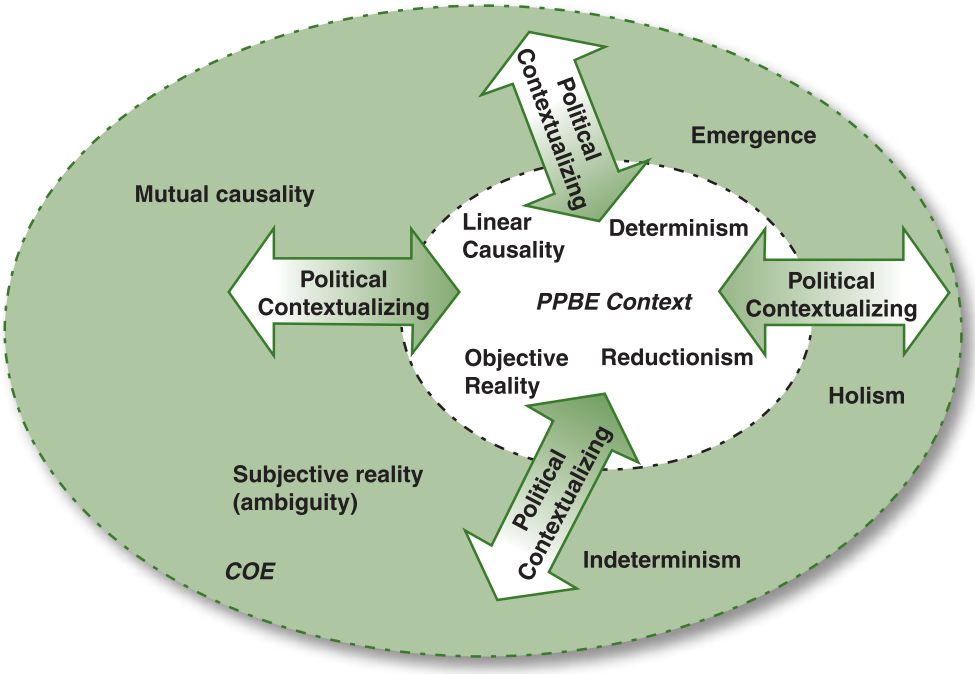
Consider that Defense managers have created the conceptual categories of internal and external environments as parsimonious coping devices to separate order (the "blue pill") from chaos (the "red pill"). As Neo struggled with the seductive stability and predictability that the blue pill promised, managers are culturally enticed to believe the DoD can operate through forms of technical rationality in the inner world, while not having to acknowledge the bounded limitations of technical rationality in the outer world (Simon, 1997).

Restated in terms borrowed from the study of cultures, managers are emic (observing as an insider) and not etic (observing as an outsider) with respect to making sense of the environment (Martin, 2002); hence, they must perceive themselves to function in both the social-psychological creation of order from disorder simultaneously and inseparably. They will realize that unilateral sensemaking in the context framed solely by the technical rationality assumptions of the "blue pill of PPBE" is a naïve undertaking if they agree about the hyperturbulent nature of the COE. The Marion quote at the beginning of this essay is worth repeating here: "Rationality, of course, is a moot issue when causality is poorly understood" (1999, p. 142).

COLLABORATIVE, PROFESSIONAL–CLIENT SENSEMAKING

Whereas the PPBE is based in the idea of being technically rational about the future, managers contend with the political context—the world of their clients. They realize that attempting to convincingly frame knowledge about the future for which no one can foretell is always the hallucination of linear causality. In that regard, PPBE has an impossible assumption of predictability when viewed in the context of

FIGURE 1. A BROADER CONTEXT FOR COMPLEX SENSEMAKING



political reason in the midst of environmental hyperturbulence. Whereas there are no irrefutable assumptions of technical rationality in the political context, political reasoning is better viewed by management professionals as a sensemaking bridge between the illusion of predictability framed by PPBE and the reality of uncertainty framed in the context of the COE. In short, their clients are engaged in a type of reasonableness with the effect of trying to imagine something indefinable into something that is workable. The more that savvy resource management professionals can work beyond the context of the PPBE process, the more open they may be to sharing different appreciations with their clients. As depicted in the flow chart shown here, they work as partners with clients to help them build the sensemaking bridge—by "comprehending, redressing, constructing meaning, interacting in pursuit of mutual understanding, and patterning" (Weick, 1995, p. 6) in the broader context of the COE.

In doing so, resource management professionals may also find new ways to think beyond the misleading sense of clarity associated with PPBE. They may have to consider the possibility that PPBE is the DoD culturally narrow construction of reality that serves as nothing but a ritual to temporarily bring a sense of clarity in the fog of chaos (Stacey, 1992; Dent, 1999). For many managers, a blind rejection of this possibility will prevent a form of "Cartesian anxiety" (Weick, 1995 citing Bernstein, 1983)—that is, the avoidance of the pain and suffering that would otherwise be associated with rejection of the Newtonian assumptions of the PPBE world. Rather than developing cynicism and distrust while observing the political sensemaking

process, an acceptance of this possibility will facilitate participating in the process as a professional sensemaker who appreciates political reasoning and the complexity of social systems in a global context. Such managers would serve to create knowledge relationships with clients rather than helping clients to enforce a Matrix-like command and control, unidirectional, and superior-subordinate relationship inherent to the dream world of PPBE.

Indeed, accepting this more complex way of shared sensemaking would create a risk for the manager and a paradox for the DoD: one centering on the idea that "command and control kills emergence" (McKelvey, 1999, p. 18); while simultaneously creating command and control structures (such as PPBE) to foster top-level accountability and responsiveness to Congress and the public. The traditional solution to this dilemma is for clients to use top-down power to manage meaning.[6] Fairhurst and Sarr put it this way:

> The essential tool of the manager of meaning is the ability to frame. To determine the meaning of a subject is to make sense of it, to judge its character and significance. To hold the frame of a subject is to choose one particular meaning (or set of meanings) over others. When we share our frames with others (the process of framing), we manage meaning because we assert (as leaders) that our interpretations should be taken over other possible interpretations (1996, p. 3).

However, if both managers and clients embrace the need for a collaborative sensemaking, the framing (usually associated with the planning, programming, and budgeting aspects of PPBE) can no longer be the sole responsibility of those appointed at the top. Any attempts to command and control information to make shared sense of a COE that is too complex for the technical rationality paradigm to explain or predict, may be perceived by the enlightened professional as a form of propaganda—and reflect a client's Machiavellian desire for the subordinate to accept mindlessly their approved construction of reality. Top-down framing (dubbed "strategic communications" by the U.S. Army) (Eder, 2007) force-fed to passive professionals will instill cynicism. Active professionals will learn to operate as "heroes under a tent," doing what they perceive they need to do despite top-down orders and espoused strategies to the contrary (Schön, 1983, p. 260). In this light, the unchallenged, top-down framing associated with PPBE is analogous to the creation of psychic prisons, where organizational power is configured to suppress differences (Morgan, 1998).

In the midst of perceived complexity of the larger environment, leaders must be permitted to emerge with significantly less emphasis on formal and hierarchical appointment. In the sensemaking associated with the COE context, involving indeterminism and mutual causality, the need for shared leadership among professionals and clients is better described as heterarchical (i.e., networked) rather than hierarchical (i.e., pyramidal) (McCulloch, 1945). Ironically, Al Qaeda and other terrorist networks seem to have already subscribed to this realization (Marion & Uhl-Bien, 2003).

TRANSFORMING TOWARD MORE HOLISTIC SENSEMAKING

This last section will propose what DoD resource professionals can do to deemphasize the paradigm of technical rationality while highlighting a more holistic approach suggested by the metaparadigm of shared sensemaking. Note the suffix, "-ing" in the following paragraph headings to indicate a recognition that an unknowable and highly complex environment can be dealt with only by rapid cycles of continuous acting and learning shared between professional resource managers and their clients. Educat-ing, develop-ing, lead-ing, communicat-ing, and organiz-ing are key processes.

EDUCAT-ING

Learning professionals collaborate with their clients. Emphases is on action research[7] couched in more effective metaphors (e.g., less toward mechanical images and more toward organic ones) (Morgan, 1998); a variety of mental models (e.g., "systems thinking," complexity theory, and competing theories of the policy process) (e.g., Senge, 1990; Weick & Sutcliffe, 2001; Sabatier, 1999, respectively); and multiple interpretive schemes (e.g., those rooted in various metaphysical perspectives) (Allison, 1969; Fisher, 1995; Hatch, 1997; Rajagopalan & Spreitzer, 1997; Ofori-Dankwa & Julian, 2000). The beliefs in best practices, doctrine, techniques, and formal procedures falsely convey a sense of known cause-and-effect relationships. For example, Schön compares the philosophy of educating based in action research with that of the traditional model of education as follows:

> Complexity, instability, and uncertainty are not removed or resolved by applying specialized knowledge to well-defined tasks. If anything, the effective use of specialized knowledge depends on a prior restructuring of situations that are complex and uncertain. An artful practice of the unique case appears anomalous when professional competence is modeled in terms of application of established techniques to recurrent events…. It is difficult for them to imagine how to describe and teach what might be meant by making sense of uncertainty, performing artistically, setting problems, and choosing among competing professional paradigms, when these processes seem mysterious in light of the prevailing model of professional knowledge (1983, pp. 19–20).

In summary, professionals educate and self-educate for uncertainty and adaptation in a holistic way rather than using forms of reductionism inherent to Newtonian science.

TRAIN-ING

Professionals recognize that the clear distinction between training and education is a cultural invention. The distinction may not be helpful from the perspective that both should deal with the unique cases based on the hyperturbulent nature of the

COE. As with educating, training should stress more individual and group learning and shared sensemaking under realistic and interactive, free-playing scenarios, and less with scripted exercises. The process is continuous and is neither episodic nor curtailed during the sensemaking process. Emphasize less the determinism associated with the task, condition, and standard model of success (Roper & Vandergriff, 2005). The notion of success comes instead from valuing bricolage, or the concept of emphasizing resilience through the creative use of existing capabilities by forming

Recognition that tasks, conditions, and standards are all in constant flux conveys a mental model more closely resembling the demands of the COE.

new ways to accomplish things as the individual or group learns. Recognition that tasks, conditions, and standards are all in constant flux conveys a mental model more closely resembling the demands of the COE. For example, the metaphor for operations and training should move away from the expectation of proper "orchestration" associated with the heuristics of PPBE to the welcome surprises of "jazz" associated with network fluidity, impromptu leadership, and improvisation. More concisely, professionals train and educate for uncertainty and value entrepreneurial invention (Weick, 1998).

DEVELOP-ING

A professional–client transformed shared sensemaking should be oriented on executing budgets while exploring ill-defined, intractable issues with an acknowledgement of the existence of wicked problems. In the COE context, executing budgets must be viewed as a continuous and collaborative sensemaking process rather than an episodic output of a top-down planning, programming, and budgeting control process with the accompanying over-valued Cartesian quest for prediction. The plan for allocating resources should become a plan-to-learn model under normal conditions of surprise and uncertainty rather than a plan-to-know process based on a myth of creating certainty and top-down control (Michael, 1997). Department of Defense resource management professionals must serve as the antitheses of the "self-serving elite who put science-based technique" as their masquerade of extraordinary knowledge (Schön, 1983, p. 340). They learn to treat their leaders as clients with whom they must have open and honest dialogue to develop sensemaking bridges to the COE. Through this partnering for the purpose of developing shared sensemaking, the façade of technical rationality is removed. The dialogue may lead to a political acceptance of significantly less orientation on the performance-based government

codified by Cartesian laws and rules and the PPBE process (such as exemplified by the Government Performance and Results Act of 1993) (Roberts, 2000).

Such a transformation would constitute a real paradigm shift (Kuhn, 1996) toward rewarding exploration and learning (i.e., "the creation of knowledge and meaning") (Kolb, 1984, p. 52) and realizing that today's success may be ephemeral as the environment continues to be hyperturbulent and as operating systems go through space and time in unpredictable trajectories. Together, DoD professionals and their client community in short should dialogue to find ways to deemphasize the PPB in PPBE and be attentive to learning while executing to develop the force with all participants engaging in sensemaking. Perhaps the supplemental appropriations based on the needs of today will become the appropriation methodology of the future, where neither the Congress nor the President will expect the DoD to perform its rain dance of PPBE.

LEAD-ING

To achieve maximum participation, the concept of hierarchical authority must transform more toward heterarchical leadership, characterized less by symbols of rank and position and more by the quality of sensemaking and ability to communicate to others new ways to pay attention to emergent patterns and embrace the inevitability of surprises. Investing in the ability of a heterarchical organization to be sensitive to weak signals of emergent patterns in the COE is superior to allocating resources based on the weak attention span of those at the top of the hierarchy who must admit

The paradox is that experience alone is no guarantee of expertness and that experienced people may be trapped in dysfunctional cultural patterns of repeating what has worked in the past—the tyranny of success in the context of a hyperturbulent environment.

that they cannot create very effective hyper-adaptive means by processing cycles of planning, programming, or budgeting (Schön, 1983; Argyris, 1991). A prominent characteristic of complex sensemaking is less reliance on hierarchical decision making and more deference to sharing and developing expertise in others (Heifetz, 1994; Weick & Sutcliffe, 2001) and to those who are artful framers of reality (Schön, 1983). The paradox is that experience alone is no guarantee of expertness and that experienced people may be trapped in dysfunctional cultural patterns of repeating what has worked in the past—the tyranny of success in the context of a hyperturbulent environment. Under the rubric of sensemaking, authority is, by design, given to the people

with the most willingness and imaginative potential to learn to deal with a continuous stream of emergent threats and opportunities.

COMMUNICAT-ING

Elaborate heterarchical communications networks can help enable more enlightened and improvisational forms of sensemaking by facilitating new sources of expertise, perhaps outside the cultural boundaries of the DoD. In a flexible communications environment, trying to predict where leadership might emerge is fruitless.

In a flexible communications environment, trying to predict where leadership might emerge is fruitless.

In short, organizational communications can no longer be considered a producer of learnedness and certainty associated with planned outcomes generated from the top; rather, it is a never-ending condition of organizing to share meaning effectively in a world of uncertainty, ambiguity, and hyperturbulence—spawning a kind of spontaneous approach to detecting and unlearning the sensemaking tools that are not working (Weick & Westley, 2001).

ORGANIZ-ING

Organizing for sensemaking may require, as often as necessary, "search conferences" comprised of Defense stakeholders that include bi-partisan members of the executive and legislative branches, along with others who can provide expert knowledge. The goal of these professionally facilitated search conferences is to gain appreciation for the environment and to create rapid strategies (Pursar & Cabana, 1998). The outcomes of the continuous participative process are statements of strategic intent that are consensus-based and that generate strong commitment (not to be confused with buy-in) across a mélange of participants. Similar to the concept of design found in the recently published Counterinsurgency Manual (Department of the Army, 2006, pp. 4-1 to 4-9), the idea of search conferences would be to create strategies that are swiftly translated into budget authorizations. Participants should avoid developing these conferences around predetermined categories and programmatic established areas. Instead, they should organize around environmental appreciation and topical issues that may reflect emergent networks of interrelated problems (i.e., messes) (Ackoff, 1999). Process consultation should be oriented on establishing and sustaining the interrelationships among the conference participants (e.g., Schein, 1998) as they engage in sensemaking. Rank and position should be left at the door to help establish a climate of collaboration and collegiality. The overarching value encouraged among

all participants is that we are all in this together. These conferences may be conducted virtually with the use of electronic communications technologies. The idea of planning and programming is transformed to more flexible forms of rapid, participative, and collective learning-while-executing.

CONCLUSIONS

A more holistic and collaborative approach to sensemaking signals a DoD-wide looped pattern of act←→learn (mutual, real time, interdependent action research during execution) rather than the more familiar unidirectional cause→effect (strategic planning, programming, budgeting ... and only then, execution) paradigm. Perhaps a case study focusing on how national laboratories associated with the U.S. Government can give insight on how work can be funded without making comprehensive predictions about how the work will turn out, would be of benefit. This article has attempted to spur some thinking about the potential of a shared professional–client sensemaking that promotes mindfulness of the limitations of positivism and the PPBE mental model symbolized by the blue pill in the movie, *The Matrix*. PPBE-style sensemaking is a form of mindlessness, creating structures that have little regard to the necessary changing political interpretations about the hyperturbulent environment. The proposition of more encompassing red pill models of educating, training, force developing, leading and organizing, and communicating may help contribute to a more transformational order of sensemaking about resourcing the force. To Defense managers, "Wake up. You have been living in a dream world."

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ENDNOTES

1. The ontological and epistemological position that does not assume reality is an objective experience. In this article, the author assumes reality is socially constructed (Berger & Luckmann, 1967; Searle, 1995).

2. In philosophical terms, the author refers to the "tools of epistemology and ontology" that Weick describes sensemakers using as "they create that which they interpret" (1995, p. 38).

3. Rutgers (1999) states, "In the course of the nineteenth century the idea of rationality became almost exclusively connected with science and technology, and emerged as the methodological determinant for objectivity and expertise. In fact, science became regarded as the paradigm of rationality. The scientific method of positivism constitutes the strongest expression of the belief in scientific rationality. The founding positivist, Comte (1798–1857), believed that empirical scientific research can not only improve the world by making better humans, but would enable them to control the ravages of nature. Positivism is premised on the idea that rational, scientific thought can solve all human problems and that there is a steady progress of science and society. As a research method, positivism goes hand in glove with empiricism—the belief that certain knowledge can only be arrived at by means of observation (ironically, contrary to rationalism). Positivists believed that it was a means to arrive at objective knowledge. Thus, not only is metaphysical argument debased as 'subjective,' but all value issues ought also to be regarded as unscientific and thereby out of the sphere of rationality" (pp. 22–23).

4. What seemingly makes technical rationality a legitimate paradigm in the minds of PPBE sensemakers is what sociologist Max Weber calls Zweckrational or a process of linear reasoning believed to establish clear means-ends linkages. "If you do X, then Y will happen as a result" This perceived and believed to be irrefutable legitimacy stems from five sub-beliefs: that an established legal code can claim obedience from members; that law is a system of abstract rules that are applied to particular cases (and that application looks after the interest of the organization within the limits of law); that the person who exercises this authority should obey in an impersonal manner; that only in the capacity of being a member is there reason to obey the law; and that this obedience is not attributed to a specific person, but the position that they occupy. In short, technical rationality is what Weber conveys as the dominant philosophy of the archetypal bureaucrat (Heydebrand, 1999).

5. These reflect a synthesis of political reasoning from the works of Machiavelli (1961/1532); Allison (1969); Kingdon (1995); Stone (1997); and Zahariadis (1998).

6. The DoD refers to this process of control as "strategic communications" in the lingo of Defense public affairs specialists (e.g., see Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, 2004).

7. The action research concept was developed by social psychologist Kurt Lewin and his colleagues in the late 1940s. His concepts spawned many to investigate phenomenological aspects of learning, to include heavily influencing David Kolb's culminating work on experiential learning. Lewin's learning model involved human shared experience-reflection-abstraction-testing cycles that produce new and often profound meaning (Kolb, 1984, p. 21).

Image designed by Harambee Dennis

SYSTEM OF SYSTEMS DEVELOPMENT FOR THE DoD: TAILORING ACQUISITION REFORM FOR EMERGING NEEDS

CDR Scott Moran, USN

When the Defense Acquisition Performance Assessment (DAPA) panel proposed sweeping reforms to address long-standing problems in defense acquisition, their recommendations did not anticipate critical challenges expected in the development of a System of Systems (SoS). Defense leaders counting on revolutionary SoS capabilities must appreciate that current and proposed acquisition systems insufficiently facilitate SoS development. This article describes the importance of adapting defense acquisition processes to enable effective SoS development and concludes with proposed modifications to the DAPA Report recommendations. Tailoring defense acquisition organization, budgeting, and requirements generation systems to overcome the challenges of SoS acquisition will be essential for tomorrow's military systems to realize their potential.

Decades of efforts to improve defense acquisition processes have made a cliché of the term "acquisition reform." Given this history, few in the acquisition community were surprised when Deputy Secretary of Defense Gordon England ordered a comprehensive assessment of Department of Defense (DoD) acquisition processes (England, 2005). However, the expansive scope Secretary England authorized for this review signaled a desire to examine the problem more holistically. His request for an approach examining "every aspect" of acquisition contrasted with many previous reform efforts that focused primarily on internal defense acquisition community issues.

Authorizing such a comprehensive approach acknowledged a past tendency to underestimate the effects of complex interactions among acquisition personnel and

other stakeholders in requirements generation, oversight, and financial management roles. The panel answering Secretary England's request met his challenge, providing an all-encompassing assessment of defense acquisition and proposing sweeping systemic reforms in its January 2006 *Defense Acquisition Performance Assessment (DAPA) Report*. If implemented, the *DAPA Report*'s key recommendations will fundamentally alter the DoD acquisition framework.

Given many current defense acquisition problems, it was natural for the DAPA assessment panel to focus primarily on observations within today's environment. However, plans for defense transformation portend difficulties that may significantly aggravate the acquisition problems experienced within DoD. In particular, plans to leverage technology to build flexible and integrated "systems of systems" will prove especially challenging.

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This article examines some misconceptions associated with system of systems (SoS) acquisition and proposes refinements to tailor the *DAPA Report* recommendations to better address these challenges. To do this, it briefly describes the defense acquisition framework to place reform efforts in context; and then shows how DoD plans demonstrate the intent to rely on advanced technological solutions, such as system of systems. This approach, while conceptually appealing, presents significant problems to the acquisition community.

One of these hurdles is the need to accept a more realistic viewpoint regarding the maturity of System of Systems Engineering (SoSE). The *Defense Acquisition Guidebook (DAG*, 2006, p. 100) begins a definition of SoSE as "planning, analyzing, organizing, and integrating the capabilities of a mix of existing and new systems into an SoS capability greater than the sum of the capabilities of the constituent parts." The *DAG* description of SoSE goes on to acknowledge the inherent complexities of this emerging discipline.[1] However, because traditional tools such as Systems Engineering (SE) have been monumentally successful in defense acquisition, there is a strong belief that SE is easily adaptable to SoS development. While SE has proven indispensable for development of enormously complex systems, the emerging demands of SoSE will likely outstrip SE's utility.

When the *DAPA Report* and the challenges of SoS development are considered together, it becomes clear that the DAPA panel's recommendations only partially address concerns that complicate SoS development. To facilitate SoS acquisition for defense needs, this article concludes with suggestions to better align the *DAPA Report* recommendations with DoD plans.

THE DEFENSE ACQUISITION FRAMEWORK: UNDERSTANDING THE SCOPE OF REFORM

Determining exactly *what* is being discussed assumes particular importance in defense acquisition because—depending on context and audience—the term "acquisition" is used to describe different constructs. Particularly important for this paper are two distinct perspectives that are commonly distinguished by the terms "little a" and "big A" acquisition.[2]

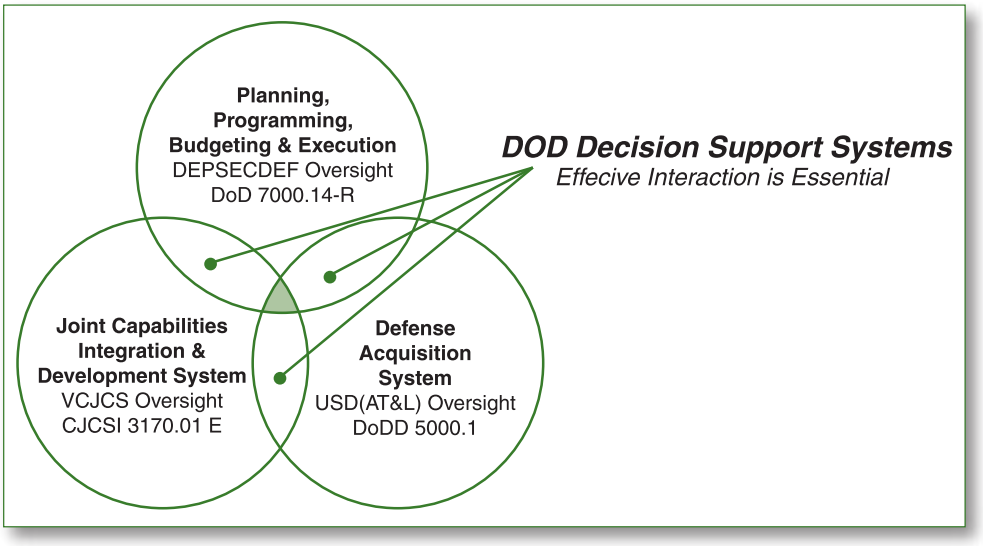
"Little a" vs. "Big A": The Defense Acquisition Framework Through Two Lenses

"Little a" acquisition describes the activities that occur within the Defense Acquisition System (DAS). Typically, factors such as cost, schedule, performance, and risk concern DAS participants as they work to develop actual systems. However, two additional and distinct decision support systems specify warfighter requirements and provide funding.

The Joint Capabilities Integration and Development System (JCIDS) is used to define and generate requirements. Resources are managed through yet another process that coordinates cost estimating and funding activities, known as Planning, Programming, Budgeting and Execution (PPBE). The triumvirate of DAS, JCIDS, and PPBE is intended to establish an integrated defense acquisition, technology, and logistics (AT&L) life cycle management framework (IFC, 2005). The term "big A" usually refers to this larger framework of three interconnected and interlinked acquisition systems (Figure 1).

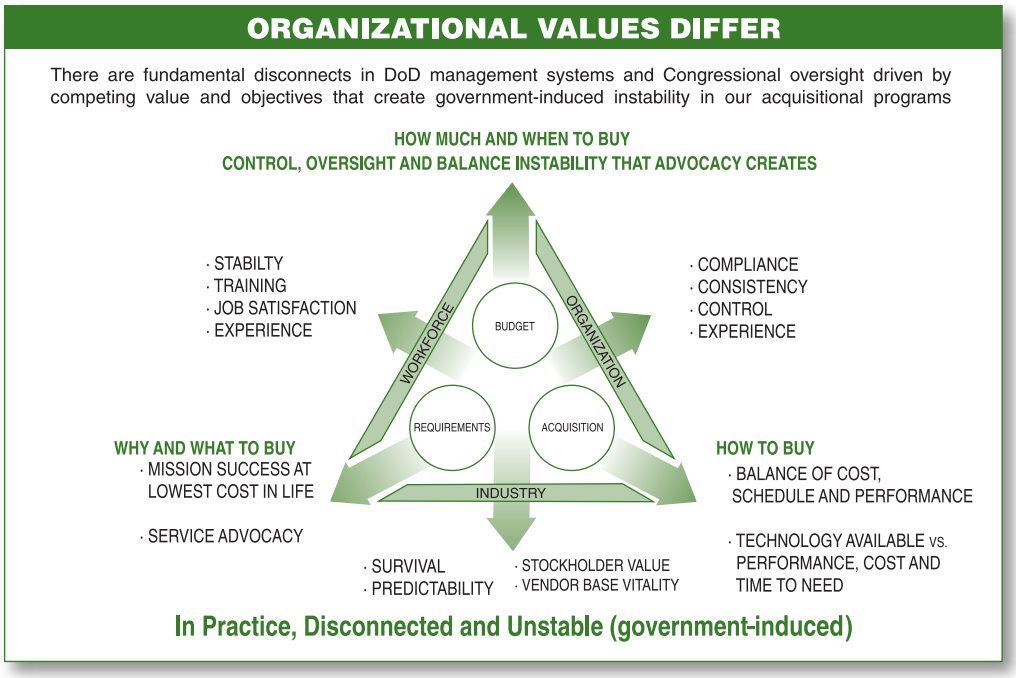
Observers of defense acquisition processes increasingly emphasize the importance of understanding problems that arise from interrelationships, interdependencies, and conflicts among these three systems. The need to harmonize different perspectives, interests, and objectives across the framework presents a fundamental defense

FIGURE 1. THREE INTERACTING SYSTEMS IN "BIG-A" ACQUISITION



acquisition challenge. However, critics sometimes question the effectiveness and feasibility of such cooperation. The *DAPA Report* (2006) focuses on this very point, characterizing current relationships as uncoordinated, fragmented, disconnected, and unstable. Furthermore, the *DAPA Report* paints a picture of even more complex stakeholder interactions, expanding the notion of "big A" to include the acquisition workforce, organizations, and industry (Figure 2).

FIGURE 2. DAPA PANEL VIEW OF ACQUISITION FRAMEWORK



DEFENSE ACQUISITION: A SYSTEM UNDER CONTINUAL REFORM

Previous observers have made similar observations of dysfunction in the "big A" framework. Notably, the landmark "Culture Report" (GAO, 1992) highlighted deep conflicts among the three decision support systems. However, these structural problems were overlooked in subsequent reform efforts in favor of more palatable, incremental changes.

The futility of such small-step acquisition reform has become increasingly apparent. The *DAPA Report* (2006) documents seven successive acquisition reform initiatives attempted since 1992. Most of these focused on process improvement within the DAS, rather than structural changes. Thus, despite well-intentioned goals of reducing costs, accelerating schedules, and better defining requirements, previous reforms have produced limited results.

THE DAPA PANEL: A BROAD MANDATE ENABLES A BOLD APPROACH

The comprehensive assessment that Secretary England requested from the DAPA panel offers an opportunity to break this cycle. Opening the examination to all aspects of acquisition, the three decision support systems were considered as an interacting system. Reporting from this broad perspective, many *DAPA Report* (2006) findings echo similar observations to those found in GAO's Culture Report.

As noted in the Culture Report, the DAPA panel uncovered incompatibilities in behavior that emerged from divergent organizational values. Differences in values stem from inconsistencies among governing instructions, driving factors (i.e., need-based, calendar-based, or event-based), stakeholder interests, and distinctions in organizational cultures. Observing these problems, the DAPA panel's findings criticize the most fundamental elements of acquisition: organization, workforce, budget, requirements, acquisition processes, and industry's role.

Several of the recommendations from the *DAPA Report* (2006) are discussed in a later section of this article. However, a major finding of the DAPA panel sets the stage for a discussion of DoD plans to employ systems of systems in the future: "strategic technology exploitation is a key factor that allows the U.S. to maintain dominant military capabilities" (p. 7). This finding is consistent with overarching guidance for defense transformation as well as multiple roadmaps that establish systems of systems as fundamental building blocks of tomorrow's forces.

ADVANCED TECHNOLOGY FOR DoD TRANSFORMATION: THE RELEVANCE OF SoS DEVELOPMENT

Improved U.S. military capabilities are invariably linked to advanced technology. Planning documents reveal high expectations for concepts such as transformation, network-centric operations, and adaptive systems of systems. However, bringing these concepts to fruition presents daunting challenges to an acquisition system that strains to provide affordable and timely capabilities to warfighters today.

DEFENSE TRANSFORMATION: CONTINUED STRESS ON THE ACQUISITION SYSTEM

Commitment to leveraging advanced technology is signaled throughout the defense establishment. The Secretary of Defense establishes networking as a cornerstone of military transformation in the *National Defense Strategy* by stating, "The foundation of our operations proceeds from a simple proposition: the whole of an integrated and networked force is far more capable than the sum of its parts" (OSD, 2005, p. 14). Uniformed leaders echo this approach. The *National Military Strategy* provides a typical example, describing the desired Joint Force as "fully integrated, networked, decentralized, [and] adaptable" (CJCS, 2004, p. 15).

Furthermore, Service plans flesh out these concepts, attributing robust capabilities to fully networked, interoperable, and adaptive systems of systems. The Air Force's

vision provides a highly optimistic example: "With advanced integrated aerospace capabilities, networked into a system of systems, we'll provide the ability to find, fix, assess, track, target, and engage anything of military significance anywhere" (USAF, 2002, p. 6).

Beyond providing state-of-the-art military capabilities, planners also envision future meta-systems as completely and flawlessly interoperable. One example is found in the USAF *Transformation Flight Plan* (2004, p. 69), which promises "a joint fire control system of systems that enables the Joint Force Commander to seamlessly across the sensor-to-shooter assets of all the Services, put a cursor over a target in a timely manner."

The difficulties experienced to date highlight the need to reconcile substantially differing opinions.

Conceptually, the acquisition community has also embraced SoS development as essential for meeting future military needs. Commitment to this principle is reflected in guidance that links success in defense transformation to "network-centric operations and on individually complex systems linked together in complex systems-of-systems" (DAG, 2006, pp. 170-171). Yet initial systems of systems development efforts suggest the need for new methodologies (Zenishek & Usechak, 2005; Brown & Flowe, 2005; Luman & Scotti, 1996). The difficulties experienced to date highlight the need to reconcile substantially differing opinions regarding the distinctions between an SoS and a highly complex system.

CONFLICTING APPROACHES TO SOS DEVELOPMENT

Capabilities projected for the technologically superior force of the future require interoperability that eclipses the state-of-the-art. Descriptions of future meta-systems imply astonishing utility and flexibility with promises of "multiple autonomous embedded complex systems that can be diverse in technology, context, operation, geography, and conceptual frame" (Keating et al., 2003, p. 41). Most important, transformation proponents envision these interlinked meta-systems providing capabilities far exceeding those of their individual components. This important aspect of an SoS—exponentially complementary capabilities—is the basis of proposals to develop affordable yet tremendously capable military forces centered on adaptive systems of systems.

Many voices in the defense acquisition community assert that the discipline of Systems Engineering is adequate for SoS development. However, findings of re-

searchers who study System of Systems Engineering raise serious questions about this position. These experts believe that the immaturity of SoSE warrants reexamination of basic assumptions regarding the ability of SE to underpin SoS development.

SYSTEMS ENGINEERING: UTILITY AND FUTURE APPLICABILITY TO AN SOS

Because the discipline of Systems Engineering is central to defense acquisition, adherents are enthusiastic about its continued validity for SoSE. Deep commitment to SE principles is reflected in high-level direction that requires all acquisition programs to be "managed through the application of a systems engineering approach" (OSD, 2003, p. 7). The *Defense Acquisition Guidebook (DAG*, 2006) fleshes out this mandate, providing a chapter dedicated entirely to SE.

In its SE chapter, the *DAG* (2006) recommends a "robust systems engineering approach" for all programs "regardless of acquisition category" (p. 21). To facilitate this, the *DAG* details SE's best practices, providing guidance on technical and management processes to be applied throughout a program's life cycle. This wholesale confidence results from decades of successful application of SE principles in developing systems of staggering complexity.

Having demonstrated enormous utility for complex development efforts, SE seems ideally suited for the interconnected systems envisioned for the future. Thus, the *DAG*'s (2006) recommendation of SE for SoS development is unsurprising: "Systems of systems should be treated and managed as a system in their own right, and should therefore be subject to the same systems engineering processes and best practices as applied to individual systems," (p. 100).

The Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) underscores this guidance in a policy memo specifically addressing SE's central role for SoSE efforts:

> Application of rigorous systems engineering discipline is paramount…. This is especially true as we strive to integrate increasingly complex systems in a family-of-systems, system-of-systems context. Systems engineering provides the integrating technical processes to define and balance system performance, cost, schedule, and risk (Wynne, 2004).

However, the Defense Department's ability to apply SE to complex systems has come under scrutiny in recent studies (DoD JDCST, 2004; *DAPA Report*, 2006). The DAG (2006) acknowledges some unique SoS development challenges, calling attention to factors such as "greater complexity of integration efforts" and "engineering under the condition of uncertainty" (p. 100). While these viewpoints reveal a budding understanding of the inherent difficulties in SoS development, the challenges associated with SoS implementation may be more daunting than currently appreciated by acquisition professionals.

SYSTEM OF SYSTEMS ENGINEERING: BEYOND ADAPTATION OF TRADITIONAL SE

Stakeholders in government and academia have begun to recognize fundamental differences between the disciplines of SE and SoSE. To develop and apply appropriate SoSE methodologies for the DoD, a System of Systems Engineering Center of Excellence (SoSECE) has been established under the auspices of the USD(AT&L). This organization has coordinated several SoSE conferences as has the Institute of Electrical and Electronics Engineers (IEEE). However, the distinctions between SE and SoSE are not yet widely appreciated. Experts at the National Center for Systems of Systems Engineering describe some of these differences in a seminal paper that characterizes SoSE maturity "in the embryonic stages of development" (Keating et al., 2003, p. 36). To frame a discussion of the dissimilarities between SE and SoSE, these authors consider eight significant areas of distinction: Focus, Objective, Approach, Expectation, Problem, Analysis, Goals, and Boundaries.

Decisions intended to alleviate one problem often carry unintended consequences that aggravate others.

Many of these differences apply directly to SoS acquisition in the DoD. Keating et al. (2003) argue that SoSE requires a fundamental shift in focus from the development of individual systems to the integration of multiple complex systems. Furthermore, Keating et al. describe the importance of methodology-based rather than process-based approaches for SoSE. While DoD has made significant progress in improving interoperability, current organizational structures are optimized for acquisition of single—albeit highly complex—systems through process-based approaches. Shifting cultural norms to reflect a focus and approach compatible with SoS development would suggest significant organizational adaptation.

Similar changes will be required to efficiently budget for SoS development efforts. Keating et al. (2003) demonstrate the importance of flexible system boundaries and pluralistic system goals in SoSE. However, these principles contrast sharply with current practices and standards that segregate acquisition funds by solid boundaries and unitary program goals. Thus, adapting the PPBE system to cope with these SoS characteristics will become increasingly important.

Generating appropriate requirements for an SoS will also require a different approach. The JCIDS operates most effectively when problems are clearly defined, expected capabilities are linked to system characteristics, and overarching objectives can be met by optimizing performance within cost and schedule guidelines. SE provides an ideal analytical framework for this JCIDS construct. In contrast, effective SoS development requires a radically different requirements paradigm that describes

"emergent" rather than defined behaviors, provides "satisfying" rather than optimizing criteria, and defines "initial responses" rather than final solutions (Keating et al., 2003, p. 40). Therefore, requirements generation will require significant cultural and procedural changes to accommodate SoS development.

Although not primarily focused on engineering issues, the DAPA panel expressed pessimism regarding the readiness and competence of DoD systems engineering to support "large-scale integration efforts" (*DAPA Report*, 2006, p. 29). The panel's recommendations address this shortfall and would significantly improve the defense acquisition community's ability to adapt to many future needs. However, tailoring these recommendations to address SoS acquisition could substantially improve DoD's ability to meet its stated goals.

DAPA FINDINGS AND RECOMMENDATIONS: ADAPTING REFORM FOR SOS ACQUISITION

The DAPA Panel returned many recommendations addressing current acquisition shortfalls. However, in three areas—Organization, Budget, and Requirements Generation—the *DAPA Report* (2006) recommendations could be adapted to better prepare the DoD for SoS acquisition.

ORGANIZATION: HEEDING THE DAPA PANEL'S CALL TO BREAK STOVEPIPES AND BARRIERS

In its broad review, the DAPA Panel identifies organizational barriers that hinder efficient program execution. Built around "highly complex" and "fragmented" mechanisms, the acquisition framework produces deeply entrenched and destructive instabilities (*DAPA Report*, 2006, p. 4). Furthermore, organizational problems extend to the highest levels of DoD bureaucracy; the DAPA Panel notes that fragmentation is institutionalized by not connecting "budget, acquisition, and requirements processes … at any level below the Deputy Secretary of Defense" (p. 24). Effectively segregated into discrete communities, stakeholders act without appreciating consequences in a broader organizational context. As a result, decisions intended to alleviate one problem often carry unintended consequences that aggravate others.

DAPA's Recommendation on Organization. The DAPA panel addresses dysfunctional relationships by proposing a fundamental reorganization to the "big A" framework. The *DAPA Report* (2006) recommends that each Service establish a four-star Acquisition Systems Command (ASC) to consolidate and integrate budget, acquisition, requirements personnel, and responsibilities. However, this approach might complicate efforts to coordinate acquisition of SoS programs with joint participation.

Organizational Problems Specific to SoS Acquisition. Consolidation of acquisition efforts within ASCs would represent an important step in overcoming cultural barriers. However, the proposal to vest this power in Service systems commands

would retain—and perhaps raise—barriers that separate individual Services. These barriers could present especially thorny problems for program managers (PMs) attempting to integrate SoS components across Service lines.

Achieving SoS interoperability requirements will require extensive ongoing coordination among developers of each component system. This coordination will only be possible within an organizational structure where a wide spectrum of cost, schedule, risk, and requirements trade-offs between component programs can be resolved. Weighing appropriate tradeoffs will be especially difficult when developers face the tremendously difficult—and poorly understood—challenge of integrating systems in various stages of maturity into a SoS. Current and proposed organizational systems simply lack the mechanisms to effectively and objectively carry out such complex assessments.

To capitalize on the promise of technological superiority offered by an SoS, developers must work within an organizational construct that fosters the emergence of complementary capabilities. The DAPA panel's recommendation to consolidate development, budgeting, and requirements functions could represent an important

Consolidating SoS development efforts in one organizational structure would offer the potential to perform limited budget trade-offs among component systems as priorities changed.

first step toward streamlining acquisition efforts, but inter-Service tensions in joint SoS programs will still exist. While PMs are certainly encouraged to perform this coordination independently, they simply lack the incentives, time, and information to do so effectively.

In some cases, Joint Program Offices (JPOs) could provide oversight for such coordination. However, JPOs incur substantial bureaucratic burdens. As systems of systems proliferate in coming years, more efficient, streamlined, and effective organizational models for joint SoS development will become essential.

The organizational structure proposed by the *DAPA Report* (2006) should be amended to clearly delineate mechanisms to facilitate inter-Service cooperation in programs with extensive joint equities, such as an SoS. One such model would assign SoS sponsorship to a lead Service. Today, acquisition sponsors assume responsibility for "all common documentation, periodic reporting, and funding actions" (CJCS, 2005, A-6). Consolidation (and expansion) of these functions for an SoS could overcome many coordination problems if a Program Executive Officer (PEO) or PM were appropriately empowered. Because this approach might be controversial within the DAPA panel's proposed Service-based ASC organizational structure, provisions

for leadership and sponsorship of joint SoS development efforts should be clearly articulated in acquisition restructuring plans.

BUDGET: EMPOWERING THE SPONSOR OF A SYSTEM OF SYSTEMS

Consolidating SoS development efforts in one organizational structure would offer the potential to perform limited budget trade-offs among component systems as priorities changed. However, implementing budget changes that could support an integrated plan to develop and introduce SoS capabilities would require more disciplined and flexible resource management than is typically demonstrated in DoD acquisition programs.

The *DAPA Report* (2006) reaffirms the existence of fiscal challenges described in many prior defense acquisition studies. However, most previous surveys focused on "little a" acquisition issues. Thus, while many prior criticisms addressed legitimate problems, some of these were symptoms of systemic flaws in the "big A" framework. The *DAPA Report* (2006) employs a wider scope to describe how interactions of the three defense acquisition decision support systems destabilize budgets.

DAPA's Recommendation on Budget Stability. To improve budget stability, the *DAPA Report* (2006) recommends establishing a Stable Program Funding Account (SPFA) for Acquisition Category I (ACAT I) programs. Programs in an SPFA would be protected against the cascade of unintended consequences flowing from budget reprioritizations. However, providing such a buffer would depart dramatically from traditional resource management processes and significantly alter entrenched power relationships.

Acknowledging the political difficulties of instituting such fundamental change in budgeting, the *DAPA Report* nonetheless focuses its SPFA recommendation on programs with the largest capital expenditures. While the *Quadrennial Defense Review Report* offers strong support for the SPFA concept, Congress may be reluctant to forego its traditional oversight of ACAT I programs (OSD, 2006). Instead, selecting a "test-bed" program that would derive great benefits from budget stability might provide a more politically realistic strategy to introduce SPFAs and generate congressional confidence in the concept. An SoS development effort offers great potential for such an initiative because the shifting boundaries and goals in SoS component systems will tend to be especially destabilizing to their budgets.

Budget Problems Specific to SOS Development. The current defense acquisition system typically rewards managers capable of obligating and expending resources that were planned years in advance. Changes in resource requirements, either above or below the appropriated level, are viewed as problems and quickly attract unwelcome scrutiny. PMs of SoS components will face aggressive oversight and burdensome inquiries if their budgets demonstrate instabilities.

However, the inherent characteristics of a SoS will likely produce less stable budgets. Division of programs into individual budget line items tends to emphasize unitary goals, as opposed to the pluralistic goals of an SoS. Even if a single sponsor were empowered to balance limited SoS resources across an array of component systems, this authority would probably be insufficient to compensate "for sudden and potentially dramatic shifts in system boundaries" that require corresponding resource shifts (Keating et al., 2003, p. 41). Furthermore, Keating et al. emphasize that budget-

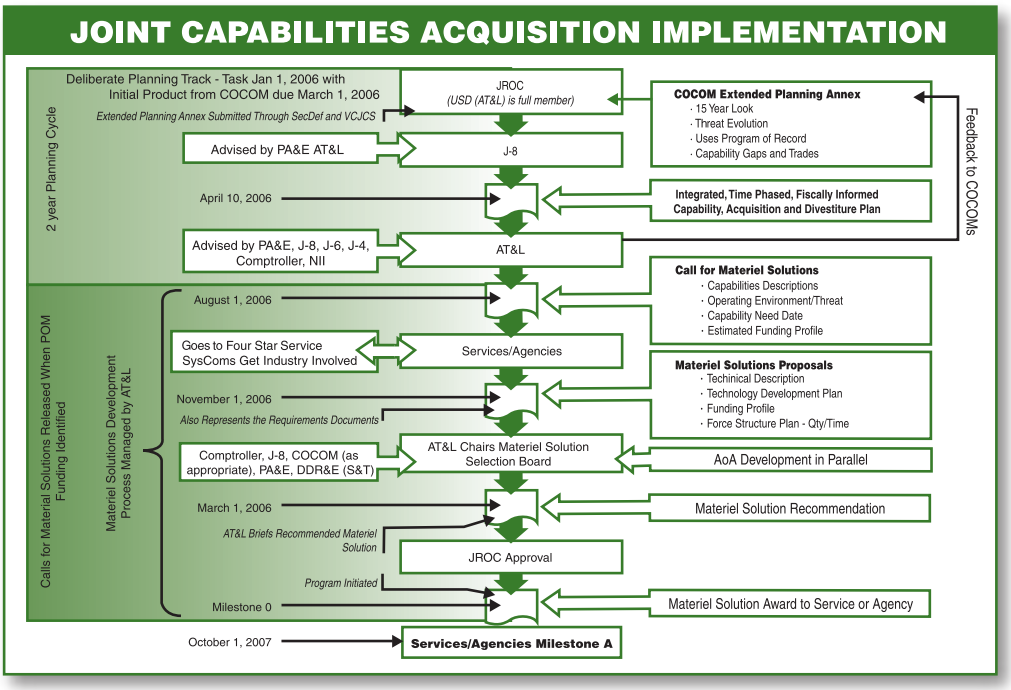
ing methodologies to operate and maintain systems of systems "once they have been fielded are scarce" (p. 43).

Given these destabilizing budget pressures, SoS acquisition will face daunting challenges in the PPBE system. This burden may aggravate resourcing tensions between component systems and jeopardize system-wide development efforts. A reasonable and effective solution for this problem would be to introduce the DAPA Panel's SPFA concept in an SoS, empowering its lead sponsor to manage budget trade-offs across the spectrum of component systems.

REQUIREMENTS: DISCIPLINE AND FLEXIBILITY, STRIKING A BALANCE IN AN SOS

As in resourcing, the DAPA panel also discovered instabilities in requirements generation that were rooted in differing organizational values. Less inclined to scrutinize details of program management and funding, requirements writers mandate "systems that are technologically unrealistic or unable to be delivered [on time]" (*DAPA Report,* 2006, p. 5). Furthermore, the *DAPA Report* describes how extended development timeframes destabilize system requirements due to the need to adapt to evolving operational environments, military priorities, acquisition rules, and overarching policies. Overall, the DAPA panel found little to recommend in the JCIDS, characterizing the system as cumbersome, overly complex, and unsuitable for continued use.

FIGURE 3. DAPA JOINT CAPABILITIES ACQUISITION AND DIVESTMENT PROCESS AND IMPLEMENTATION PLAN



DAPA's Recommendation on Requirements. The DAPA Panel recommended scrapping JCIDS to implement a new system (Figure 3). Its report suggests an alternative Joint Capabilities Acquisition and Divestment (JCAD) planning system that would streamline and simplify processes to "enhance requirements stability" (*DAPA Report*, 2006, p. 44). However, features of the JCAD plan that emphasize a more linear approach and increased inter-Service competition might interfere with effective SoS requirements generation.

The JCAD system would expect the Joint Staff Director for Force Structure, Resources and Assessment (J-8) to develop an "integrated, time-phased, fiscally informed capability, acquisition, and divestiture plan" (*DAPA Report*, 2006, p. 39). The USD(AT&L) would then use the J-8 plan to invite competing proposals for material solutions from the Services. While this procedure could significantly improve requirements generation for many programs, it could introduce counterproductive tensions for integrated SoS development.

REQUIREMENTS PROBLEMS SPECIFIC TO SOS DEVELOPMENT

Developing requirements for a complete SoS will likely require a fresh approach. Most critics of the JCIDS rightly criticize its inability to stabilize requirements. However, proposals to introduce additional discipline in requirements generation fail to address the expected challenges of SoS development. Instead, SoSE experts emphasize the need for increased flexibility to cope with SoS complexities.

Developing requirements for a complete SoS will likely require a fresh approach.

The description of SoS development published by Keating et al. (2003) suggests elements of a new approach. At inception, one must "proceed with the assumption that the initial problem definition or mission is always incorrect or suspect" (p. 43). Additionally, requirements for SoS components will be difficult to articulate as "increasing information intensity, contextual richness, and problem complexity all contribute to the need for evolving systems engineering to address emergent complex systems problems" (p. 40). In essence, SoSE requires adaptation to changing requirements beyond what current acquisition processes allow.

The proposed JCAD system does not provide an effective construct to address these complexities. As described in the *DAPA Report* (2006), JCAD processes are linear and sequential. This process is ideally suited for easily described capability needs, but will not facilitate an appreciation for complex component system interactions that contribute to SoS system capabilities.

SoSE experts envision future requirements generation as a fluid process, capable of coping with shifting environments. Accordingly, SoS requirements must provide for flexibility in parameters and boundaries. Because overall SoS performance results from complex component system interactions, the J-8's ability to produce an "integrated, time-phased, fiscally informed capability, acquisition, and divestiture plan" (*DAPA Report*, 2006, p. 39) that captures SoS capabilities is questionable. Instead, the J-8 should describe SoS requirements more holistically. The proposed JCAD system could accommodate such an approach by emphasizing overarching capabilities and architectures, rather than traditional program proposal elements such as system technical descriptions, delivery profiles, and production quantities.

Furthermore, the JCAD process pits Services against one another to compete for material solutions. This competition would hinder development and integration of SoS components across Service boundaries. As the JCAD process is currently envisioned, Services competing to develop SoS components would lack incentives to prioritize capabilities that enhanced other Services' needs. SoS development in this parochial manner would quickly degenerate into inefficient parallel engineering of systems that might form a loosely interoperable system, but would remain a far cry from the capabilities that integrated SoSE could achieve.

Several modifications to the proposed JCAD could tailor its processes to better support SoS requirements generation. First, because SoS development must be flexible and iterative, the J-8 should describe the incremental value desired for new SoS (or particular component) capabilities rather than attempt to create an integrated, time-phased capability plan prior to program inception. Second, material solutions proposals for SoS components should broadly describe capabilities and integrating architectures instead of specific technical descriptions and force structure proposals. Finally, inter-Service competition should be based on selecting the best leader for SoS integration efforts. This approach would facilitate joint cooperation on proposals, establishing a more collaborative atmosphere for SoS development.

CONCLUSION—RECOMMENDATIONS TO TAILOR REFORM

Decades of unsuccessful reforms have frustrated generations of professionals seeking to fix defense acquisition through incremental improvements. The DAPA panel proposes to break this pattern with a sweeping reform plan, actionable recommendations, and an implementation strategy. While these proposals offer significant promise, they do not anticipate critical challenges presented by SoS development.

While defense leadership is counting on SoS capabilities, the current and proposed acquisition systems are ill equipped to facilitate actual development of these systems. To better facilitate SoS acquisition, the following modifications to the DAPA Report recommendations are suggested:

- ***Organization.*** Plans to restructure defense acquisition must incorporate mechanisms to coordinate joint efforts. Assignment of a lead-sponsor to oversee inter-Service collaboration in SoS development would support this goal.

- ***Budget***. Efforts to stabilize acquisition budgets, such as the SPFA, should be introduced in an SoS development program. This arrangement would empower an SoS lead-sponsor to make trade-offs among component systems.
- ***Requirements Generation.*** The proposed JCAD processes should be tailored to three specific guidelines:
  a) Focus SoS requirements on incremental capability needs and architectures instead of detailed technical descriptions.
  b) Encourage earlier joint cooperation on SoS material solutions.
  c) Use competition to select SoS lead-sponsorship instead of Service-specific material solutions for SoS components.

Incorporating these ideas in today's defense acquisition reforms would help catalyze transformations in the acquisition workforce needed for SoS development and significantly improve the likelihood that tomorrow's systems will realize their potential.

DISCLAIMER

The views expressed in the article are the author's and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

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ENDNOTES

1. SoSE is a top-down, comprehensive, collaborative, multidisciplinary, iterative, and concurrent technical management process for identifying system of systems capabilities; allocating such capabilities to a set of interdependent systems; and coordinating and integrating all the necessary development, production, sustainment, and other activities throughout the life cycle of a system of systems. The overall objective for developing a system of systems is to satisfy capabilities that can only be met with a mix of multiple, autonomous, and interacting systems. The mix of constituent systems may include existing, partially developed, and yet-to-be-designed independent systems (DAG, 2006, p. 100).

2. Many variations of the "little a" vs. "big A" terminology can be found, but nearly all represent the same basic principle discussed here.

Image designed by Schatz Publishing Group

A GLIMPSE INTO DoD WEAPON SYSTEMS PROGRAMS

Andy Fainer

An important strategic topic confronting the United States of America is sustaining Department of Defense (DoD) weapon systems as part of the overall defense life cycle management process. For the past several decades, billions of taxpayer dollars have been spent on weapon systems annually. The lives of U.S. Armed Forces members and the people they protect depend upon the quality of these weapon systems. As these weapon systems have become more sophisticated and more complex coupled with a decrease in the size of the U.S. Armed Forces over the past 30 years, the military has become increasingly reliant on these weapon systems for our nation's security.

This article focuses on three major aspects of the topic: (a) background information, in which key DoD documents and concepts such as the 2006 Quadrennial Defense Review (QDR), 2005 National Defense Strategy and logistics transformation, including Future Logistics Enterprise, will be discussed; (b) the defense life cycle management system will be discussed; and (c) an analysis of the defense life cycle management system, which is covered by six Government Accountability Office (GAO) reports.

BACKGROUND

DoD is the executive department responsible for organizing and managing all of the government's agencies and functions relating to national security and the military. The February 2006 QDR serves as a roadmap for change to transform the U.S. military to an outcome-oriented, capability-based force to better support the joint warfighter well into the 21st century. It calls for a continuing adaptation and reorientation for an integrated joint force that is more capable to defend our national interests as well as to deter and defeat our adversaries. The QDR shapes DoD's plans, policies, and programs into a broader strategy and, later, becomes part of the President's budget request.

The cornerstone of the 2006 QDR is the March 2005 National Defense Strategy. Although the U.S. military maintains considerable technological advantages in the world, our adversaries are starting to catch up. Threats are categorized as traditional, irregular, catastrophic, and disruptive. A traditional challenge uses military capabilities and forces in military conflict. An irregular challenge uses unconventional methods to offset a stronger opponent's traditional advantages. A catastrophic challenge uses weapons of mass destruction (WMD) or similar methods yielding WMD-like effects. A disruptive challenge is when an adversary finds a breakthrough technology that nullifies a U.S. advantage (DoD, March 2005).

Although the U.S. military maintains considerable technological advantages in the world, our adversaries are starting to catch up.

Considering these four threats, the QDR identified four focus areas: (a) defeating terrorist networks, (b) defending the homeland in depth, (c) shaping the choices of countries at strategic crossroads, and (d) preventing hostile states and non-state actors from acquiring or using WMD (DoD, 2006). These inter-related focus areas are the foundation of the force planning construct, showing the capabilities and forces needed to mitigate the four threats (DoD, 2006). The force planning construct determines the size of the force (capacity) and the types of capabilities (forces and equipment) needed for a diverse range of scenarios (DoD, 2006). During this QDR, senior leaders confirmed the four focus areas, but divided the force planning construct into three objective areas: homeland defense, war on terror/irregular warfare, and conventional campaigns (DoD, 2006).

The 2006 QDR listed the need for the following types of capabilities:

- Security cooperation and engagement activities including joint training exercises, senior staff talks, and officer and foreign internal defense training to increase understanding, strengthen allies and partners, and accurately communicate U.S. objectives and intent. This will require both new authorities and 21st century mechanisms for the interagency process.
- Considerably improved language and cultural awareness to develop a greater understanding of emerging powers and how they may approach strategic choices.
- Persistent surveillance, including systems that can penetrate and loiter in denied or contested areas.
- The capability to deploy rapidly, assemble, command, project, reconstitute, and re-employ joint combat power from all domains to facilitate assured access.

- Prompt and high-volume global strike to deter aggression or coercion and, if deterrence fails, to provide a broader range of conventional response options to the President. This will require broader authorities from the Congress.
- Secure broadband communications into denied or contested areas to support penetrating surveillance and strike systems.
- Integrated defenses against short-, intermediate-, and intercontinental-range ballistic and cruise missile systems.
- Air dominance capabilities to defeat advanced threats.
- Undersea warfare capabilities to exploit stealth and enhance deterrence.
- Capabilities to shape and defend cyberspace.
- Joint command and control capabilities that are survivable in the face of WMD-, electronic-, or cyber-attacks (DoD, 2006).

The 2001 QDR called for improved effectiveness and efficiency in moving and sustaining military forces in distant theaters, which included efforts to have a quicker deployment process and reduce the logistics footprint and its associated costs. The 2006 QDR called for examining supply chain logistics costs by showing the relationship between resources and supply chain logistics to better understand the costs they incur. Also, it called for continuous performance improvement. For example, DoD uses Radio Frequency Identification (RFID) to carry out logistics support through automated asset visibility and management. The RFID allows for the sharing, integration, and synchronizing of data from the strategic to the tactical level, which shows the cause-and-effect relationship between resources and readiness. Using RFID and implementing Lean Six Sigma and performance-based logistics will markedly improve DoD's supply chain (DoD, 2006).

To improve sustainment capability by achieving an integrated joint force that is more agile and more rapidly deployable with a reduced logistics footprint, DoD adopted the Future Logistics Enterprise (FLE). It serves as a near-term logistics blueprint to strengthen the warfighter from 2005 to 2010 through end-to-end customer service and enterprise integration into the 21st century (FLE, n.d.).

The FLE has six interrelated initiatives to meet the requirements of the QDR and the National Defense Strategy.

Depot Maintenance Partnership. Depot maintenance services cost over $17 billion annually. The purpose of this initiative is to increase partnerships with the commercial sector. Due to national security, DoD will continue to retain depot maintenance capability, but will encourage increased private sector investment in depot infrastructure, better facility and equipment management, and better depot business practices (FLE, n.d.).

Condition-Based Maintenance Plus (CBM+). Currently, DoD is unable to predict equipment failures in their maintenance programs, resulting in excessive supply

chain costs. The purpose of this initiative is to improve the operational availability and readiness of weapon systems life cycles at a decreased cost by using improved maintenance capabilities and integrated logistics and business processes (FLE, n.d.).

Total Life Cycle Systems Management (TLCSM). Weapon systems sustainment uses 80 percent of DoD logistics resources or approximately $64 billion annually (Cothran, Fowler, & Kratz, 2002). DoD is changing to a performance-based weapon systems sustainment model to achieve weapon systems performance integration across government and industry. The program manager (PM) manages and is accountable for the development of the weapon system and is responsible for meeting cost, schedule, and performance factors while considering the various and changing warfighter performance requirements in this process. Former Assistant Deputy Under Secretary of Defense for Logistics Plans and Programs Louis Kratz, stated:

> One of the fundamental tenets of performance-based logistics is the acquiring of weapon system support as an integrated package based on objective outcomes, such as system availability. The objective outcomes—or operational performance requirements of the customer—will be documented in a formal performance agreement document, negotiated across all stakeholders, consistent with the Services' corporate structure. The performance agreement defines system performance expectations (and corresponding support required), resources required to provide that level of performance, commitment to provide those resources, and signature by appropriate stakeholders (p. 51).

End-to-End Distribution. The purpose of this initiative is to enhance the flow of materiel to the end user, while at the same time, synchronizing deployment and sustainment efforts into an integrated, end-to-end distribution system (Staff Feature, 2003).

Executive Agents (EA). The purpose of this initiative is to ensure that EA designations match warfighter requirements with the National Defense Strategy by supporting the warfighter "across the full spectrum of operations/including support on an end-to-end basis and rapid response to all deployments" (p. 3).

Enterprise Integration. The purpose of this initiative is to unite information technologies in order to implement new logistics business processes.

None of these six initiatives can function by itself. Each initiative helps the other five initiatives by building an integrated logistics enterprise.

Kratz stated that "the most powerful weapon in the world is useless if we can't deploy and use it effectively" (Cothran, Fowler, & Kratz, 2002, p. 50). Logistics transformation serves the warfighter threefold: (a) to adopt the best business practices, (b) to have a logistics system open architecture so decision makers can use

integrated logistics information, and (c) to better logistics responsiveness to the joint warfighter (Staff Feature, 2003). As outlined in the 2006 QDR, the United States faces several types of dangerous threats. Logistics transformation, including the Future Logistics Enterprise, is needed in order to maintain technologically superior weapon systems for our well-deserving warfighter. Logistics matters have often been crucial in determining the outcome of wars.

DEFENSE LIFE CYCLE MANAGEMENT SYSTEM

The 2006 QDR described the need for continued transformation of acquisition and logistics processes in order to be more agile and more expeditionary, to increase reliability of DoD weapon systems, and to reduce logistics footprint. The defense life cycle management system is a total life cycle management system. Established by Department of Defense Instruction 5000.2, Operation of the Defense Acquisition System, in May 2003 as a revised policy, the defense life cycle management system is a knowledge-based, phased, evolutionary process used for the acquisition of major defense weapon systems.

The defense acquisition system uses a streamlined management process that delivers capable, reliable, and sustainable systems to the user.

DoD has three major decision-making support systems to support the overall defense life cycle management system: (a) Planning, Programming, Budgeting & Execution (PPBE); (b) Joint Capabilities Integration and Development System (JCIDS); and (c) Defense Acquisition System. These three systems use an integrated approach for strategic planning, identification of military capabilities' needs, system acquisition, and program and budget development. The three support systems work together simultaneously while the phases are carried out throughout the life cycle.

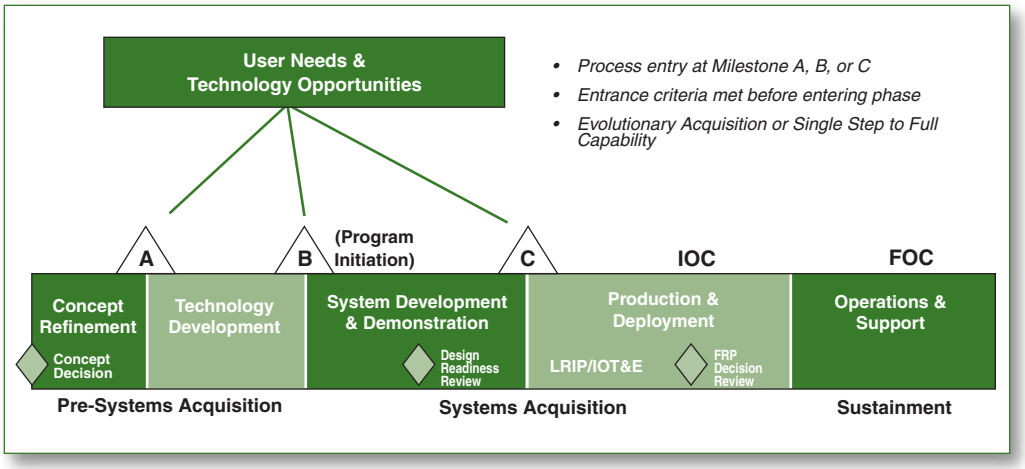
The PPBE is DoD's primary resource allocation process. The PPBE has three objectives. First, it is a biennial, calendar-driven process used for obtaining funding for major weapon systems acquisition. Second, it provides a factual basis for affordability assessment and resource allocation decisions. Third, it offers a formal structured system for making decisions on policies, strategies, prioritized goals, and the development of necessary forces and capabilities to accomplish DoD's various missions.

The JCIDS is dependent on warfighting deficiencies or needs. It assesses mission requirements and strategies for meeting those requirements as well as providing the basis for establishing priorities (DAU, ACQ-101, Lesson 2).

The defense acquisition system uses a streamlined management process that delivers capable, reliable, and sustainable systems to the user. It is an event-driven,

risk management process that uses periodic reviews and program approvals to progress into subsequent efforts of the acquisition life cycle. The process also connects milestone decisions to demonstrated accomplishments.

FIGURE 1. THE DEFENSE ACQUISITION MANAGEMENT FRAMEWORK



The framework, as depicted in the framework chart shown here, is divided into three activities: Pre-Systems Acquisition, Systems Acquisition, and Sustainment. These activities are divided into five phases: Concept Refinement, Technology Development, System Development and Demonstration (SDD), Production and Deployment, and Operations and Support. A milestone or decision point comes before each phase. The concept decision approves entry into the Concept Refinement Phase. Milestone A approves entry into the Technology Development phase. Milestone B approves entry into the SDD. The Design Readiness Review approves entry into the System Demonstration phase. Milestone C approves entry into the Production and Deployment Phase. The Full-Rate Production Review authorizes Full Rate Production. The two activities of Systems Acquisition and Sustainment are divided into six work areas: System Integration, System Demonstration, Low Rate Initial Production, Full-Rate Production and Deployment, and Sustainment and Disposal.

The acquisition process begins with a selected concept to meet a particular capability need. In the Concept Decision review, the Milestone Decision Authority (MDA) determines entry into the Concept Refinement phase. Also, a date for Milestone A is established and an Acquisition Decision Memorandum (ADM) is prepared and documents the decision's results. Entry into the first phase does not signify a new acquisition will begin.

ANALYSIS OF THE DEFENSE LIFE CYCLE MANAGEMENT SYSTEM

The 2006 QDR stated there is an increasing, profound concern among DoD's senior leadership and Congress or, more specifically, the GAO, about the Major Defense Acquisition Programs (MDAP). This lack of confidence is a result of measuring

weapon systems acquisition by cost, schedule, and performance. These acquisition programs are unpredictable and unstable. Ongoing reviews for acquisition improvements are being conducted both within and outside DoD to enforce these acquisitions, resulting in better outcomes for the taxpayer and more responsive support to the joint warfighter in the 21st century. The major problems addressed by GAO reports are summarized below.

First, the United States has the world's best weapon systems, unrivaled in superiority. The process to deploy these systems needs to be fixed. In today's acquisition environment, 40 percent cost increases are common, which add up to tens of millions of dollars, schedule delays that add up to years, and rebaselining of some large and expensive programs; indeed, some programs are even scrapped. Consequently, reduced quantities and capabilities are delivered to the warfighter.

For the past 35 years GAO has documented these problems. Since DoD will be spending more than $1.4 trillion dollars for new weapon systems between 2005 and 2009, quality and time are essential to maintain weapons superiority, quickly counter threats from the nation's adversaries, and better protect and enable the warfighter. Also, using constant 2006 dollars, the top five programs in 2001 cost $290.8 billion while the top five programs in 2006 totaled $550 billion. Considering this staggering, increased dollar spending for weapon systems, the nation will be faced with taking funds from other federal programs to fund these systems or to reduce funding for these systems.

Second, DoD does not separate long-term needs from wants. DoD starts many programs that it cannot afford. Each Service competes for funding creating a Service-centric structure and fragmented decision-making approach. It does not prioritize programs based on customer needs and DoD's long-term vision. Many times when a program needs funds because of cost increases or schedule delays, funds are taken away from other programs. This rewards poor performing programs (GAO, March 2007).

An integrated portfolio management investment strategy, as used successfully in the commercial world, would achieve more executable programs and ensure better return on investments. More importantly, warfighters would receive greater quantities and capabilities as promised to them. An investment strategy would prioritize the order of needed capabilities and match them up against resources—dollars, technologies, time, and people required to obtain these capabilities as well as define incremental product development programs for obtaining these capabilities and establish controls so the requirements, funding, and acquisition processes would work together. Without an integrated investment strategy, all other improvements will fail as shown in the past (GAO, March 2007).

Third, in 2003 DoD adopted the defense life cycle management system. This is a knowledge-based, evolutionary product development approach. GAO examined programs that began after this system started. DoD is not following it. Early decision points in the system are frequently bypassed, resulting in decision makers committing programs to premature system demonstration and initial manufacturing in the face of significant unknowns about technology, design, and production.

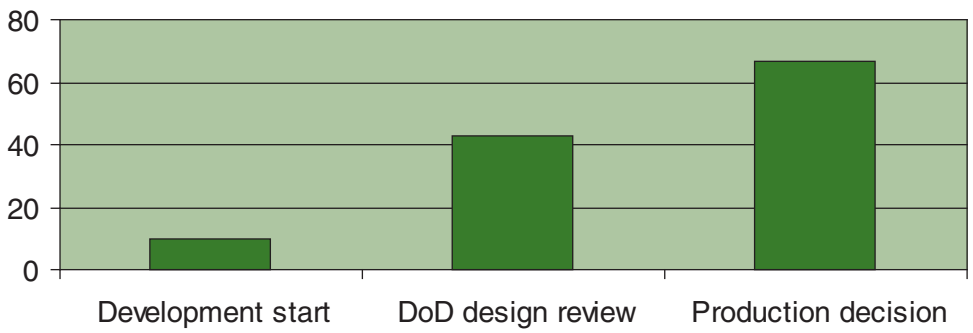
Critical points such as Milestones A and B, the Design Readiness Review, and Milestone C are not followed at all or only partially. Programs start system develop-

TABLE 1. TECHNOLOGY MATURITY AND PROGRAM OUTCOMES

Program	Percent increase in R&D (first full estimate to latest estimate)	Percent of critical technologies and associated maturity level at development start
Advanced Threat Infrared Countermeasure/Common Missile Warning System	5.6	50% (3 of 6) at 6 or higher
C-5 Reliability Enhancement and Reengining Program	2.1	100% (11 of 11) at 6 or higher
DD(X) Destroyer	417.3	25% (3 of 12) at 6 or higher
Future Combat System	50.8	32% (17 of 52) at 6 or higher
Joint Strike Fighter	30.1	25% (2 of 8) are 6 or higher

(GAO, 2005, p. 42)

TABLE 2. PERCENT OF PROGRAMS THAT ACHIEVED TECHNOLOGY MATURITY AT KEY JUNCTURES



(GAO, 2006, p. 11)

ment with immature technologies (DoD, April 2006). The Army's Future Combat System entered the SDD phase with 32 percent of its critical technologies mature. The Air Force's Joint Strike Fighter began SDD with only 25 percent mature technologies. When programs start development with mature technologies, they incur lower development and unit cost increases than those programs starting with immature technologies. Table 1 shows five examples.

History shows that programs with lower levels of knowledge at critical points lack demonstrated knowledge in the process and will continue to stay behind (Table 2).

TABLE 3. COST AND SCHEDULE OUTCOMES FOR 6 OF THE 10 LARGEST DEVELOPMENT PROGRAMS SORTED BY PERCENT OF SYSTEM DEVELOPMENT REMAINING

Programs	Percent development cost growth	Delay in delivery of initial capability in months	Percent of development remaining
Aerial Common Sensor	45%	24	85%
Future Combat System	48%	48	78%
Joint Strike Fighter	30%	23	60%
Expeditionary Fighting Vehicle	61%	48	49%
C-130 Avionics Modernization Program	122%	Delays anticipated due to program restructure	Undetermined due to program restructure Delays anticipated due to program restructure
Global Hawk (RQ-4B)	166%	Delays anticipated due to program restructure	Delays anticipated due to program restructure

(GAO, 2006, p. 10)

Fourth, Tables 3 and 4 show that immature technologies that advance without adequate demonstrated knowledge result in cost increases and schedule delays; thus, DoD delivers reduced quantities and capabilities to the warfighter and, ultimately, loses buying power.

Table 4 gives examples of DoD programs with reduced buying power (GAO, April 2006).

Fifth, to improve the defense life cycle management system, an item's technical data must be included and readily available. Technical data are recorded information used to define a design and to produce, support, maintain, or operate the item (GAO, July 2006). These data represent a significant element in the life cycle of a weapon system because they may be used for decades. The Army and the Air Force have experienced sustainment limitations on several deployed weapon systems because they lacked needed technical data rights. They have not been able to take advantage of cost savings and meet legislative requirements for depot maintenance. GAO pointed out seven weapon systems lacking technical data rights: C-17, F-22, and C130J aircraft,

TABLE 4. EXAMPLES OF DOD PROGRAMS WITH REDUCED BUYING POWER

Programs	Initial Estimate	Initial quantity	Latest estimate	Latest quantity	Percent of unit cost increase
Joint Strike Fighter	$189.6 B	2,866 aircraft	$206.3 B	2,458 aircraft	26.7%
Future Combat Systems	$82.6 B	15 systems	$127.5 B	15 systems	54.4%
F-22A Raptor	$81.1 B	648 aircraft	$65.4 B	181 aircraft	188.7%
Evolved Expendable Launch Vehicle	$15.4 B	181 vehicles	$28.0 B	138 vehicles	137.8%
Space Based Infrared System High	$4.1 B	5 satellites	$10.2 B	3 satellites	315.4%
Expeditionary Fighting Vehicle	$8.1 B	1,025 vehicles	$11.0 B	1,025 vehicles	35.9%

(GAO, 2006, p. 5)

the Up-armored High-Mobility Multipurpose Wheeled Vehicle, the Striker family of vehicles, the Airborne Warning and Control System aircraft, and the M4 carbine (GAO, July 2006). Long-term technical data need to be in the requirements before contract solicitation issuance (GAO, July 2006).

Sixth, the definition of success needs redefining. In the commercial world, success is defined by maximizing profit. At DoD, success is defined by the ability to obtain funds for new programs and to maintain funding for current, ongoing programs. Optimistic cost, schedule, and technology readiness factors attract funding. Honest assessments could result in a loss of funding. Delayed testing is preferred over early testing because bad news could result in a loss of funds. Success measures such as risk reduction, knowledge-based decision making, discipline, collaboration, trust, commitment, consistency, realism, and accountability could result in better outcomes for DoD (GAO, 2005).

CONCLUSION

DoD's acquisition of major weapon systems represents one of the most crucial and expensive activities in the federal government. Its impact is critical on the nation's economic and fiscal policies, especially considering the current long-term fiscal imbalances along with increasing conflicts over increasingly scarce resources. This could damage our national security. For the past several decades, deep concern

over DoD's management effectiveness of these weapon systems is prompting DoD to change business practices. By following DoD's defense life cycle management system, each weapon system could be an affordable, worthwhile investment and an executable program and, thus, achieve a better acquisition outcome. DoD is transforming military operations to function as a joint force on the battlefield in accordance with the 2006 QDR.

DISCLAIMER

The views expressed in this article are the author's and do not reflect the official policy or position of Information Technology, E-Commerce, and Commercial Contracting Center (ITEC4-W).

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- Papers will be evaluated by a panel selected by the DAUAA Board of Directors and the DAU Director of Research.
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Authors should become familiar with the construction of previous *Defense ARJ*s and adhere to the use of endnotes versus footnotes, formatting of bibliographies, and the use of designated style guides. *It is also the responsibility of the corresponding author to furnish government agency/employer clearance with each submission*.

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We welcome submissions from anyone involved in the defense acquisition process. Defense acquisition is defined as the conceptualization, initiation, design, development, testing, contracting, production, deployment, logistic support, modification, and disposal of weapons and other systems, supplies, or services needed by the Department of Defense (DoD), or intended for use to support military missions.

RESEARCH ARTICLES

Manuscripts should reflect research or empirically supported experience in one or more of the aforementioned areas of acquisition. Research, lessons learned, or tutorial articles should not exceed 4,500 words. Opinion articles should be limited to 1,500 words.

Research articles are characterized by a systematic inquiry into a subject to discover/revise facts or theories.

MANUSCRIPT SECTIONS

A brief abstract (120-word limit) provides a comprehensive summary of the article and must accompany your submission. Abstracts give readers the opportunity to quickly review an article's content and also allow information services to index and retrieve articles.

The introduction, which should not be labeled, opens the body of the paper and states the problem being studied and the rationale for the research undertaken.

The methods section should include a detailed methodology that clearly describes work performed. Although it is appropriate to refer to previous publications in this section, the author should provide enough information so that the experienced reader need not read earlier works to gain an understanding of the methodology.

The results section should concisely summarize findings of the research and follow the train of thought established in the methods section. This section should not refer to previous publications, but should be devoted solely to the current findings of the author.

The discussion section should emphasize the major findings of the study and its significance. Information presented in the aforementioned sections should not be repeated.

RESEARCH CONSIDERATIONS

Contributors should also consider the following questions in reviewing their research-based articles prior to submission:

- Is the research question significant?
- Are research instruments reliable and valid?
- Are outcomes measured in a way clearly related to the variables under study?
- Does the research design fully and unambiguously test the hypothesis?
- Are needed controls built into the study?

Contributors of research-based submissions are also reminded they should share any materials and methodologies necessary to verify their conclusions.

CRITERIA FOR TUTORIALS

Tutorials should provide special instruction or knowledge relevant to an area of defense acquisition to be of benefit to the DoD Acquisition, Technology, and Logistics workforce.

Topics for submission should rely on or be derived from observation or experiment, rather than theory. The submission should provide knowledge in a particular area for a particular purpose.

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Opinion articles should reflect judgments based on the special knowledge of the expert and should be based on observable phenomena and presented in a factual manner; that is, submissions should imply detachment. The observation and judgment should not reflect the author's personal feelings or thoughts. Nevertheless, an opinion piece should clearly express a fresh point of view, rather than negatively criticize the view of another previous author.

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