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# ACQUISITION

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Hard evidence is needed to provide an accurate gauge of DoD spending efficiency. This study compares DoD and commercial spending on specific items, shows that DoD spends significantly less than its commercial counterparts on similar items. These findings question the widely-held beliefs about the inherent inferiority and inefficiency of DoD purchasing and acquisition. The findings also argue for much more careful research on purchasing and acquisition, so that the likely effects of reforms are known.

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- 355 - THE ROLE AND NATURE OF ANTI-TAMPER TECHNIQUES  
IN U.S. DEFENSE ACQUISITION**  
*Lt Col Arthur F. Huber II, USAF, and Jennifer M. Scott*

Military technology can be compromised following foreign sales to an ally, accidental loss, or capture during a conflict by an enemy. Because U.S. military hardware and software have a high technical content that provides a qualitative edge, protection of this technological superiority is a high priority. Program managers can mitigate such risks with a relatively new set of technologies inclusively known as "anti-tamper." Program managers need to know the state of the art in anti-tamper technology and of the emerging DoD and U.S. Air Force policy on its use. This article covers anti-tamper policies; explains how, where, and when to insert these technologies; and describes some anti-tamper technologies now in use.

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### 369 - **PAVING THE WAY FOR PRICE-BASED ACQUISITION**

***Edward L. Will***

One of the leading visions of the Defense Reform Initiative is “igniting a revolution in business affairs within the Department of Defense that will bring to the Department management techniques and business practices that have restored American corporations to leadership in the marketplace” (Cohen, February 1998). The current study of price-based acquisition (PBA) was first recommended by Secretary of Defense Cohen in his Section 912 report (April 1998). It is an important step in this direction, and is important to another DoD goal: civil-military integration. Acquisition reform initiatives over the past several years—including waivers of cost and pricing data and other price analysis methods—have already paved the way for changing to PBA. And they have demonstrated DoD can rely on these approaches to obtain best value for the war-fighter and taxpayer, reducing acquisition cost and cycle time.

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### 383 - **SPS AND BEYOND: INNOVATING ACQUISITION THROUGH INTELLIGENT ELECTRONIC CONTRACTING**

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The Standard Procurement System (SPS) uses information technologies (IT) to support defense procurement through workflow technology. Although SPS has overcome many of the severe pathologies associated with the Defense procurement process, it is only a humble beginning for the application of state of the art in electronic contracting. This article outlines key aspects and limitations of next-generation information technology including waivers of cost and pricing data and other price analysis methods. SPS officials are challenged to investigate and incorporate these powerful technologies into future electronic contracting systems to improve procurement process performance.

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### 395 - **CIVIL-MILITARY INTEGRATION: THE CONTEXT AND URGENCY**

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As defense budgets decline, progress in acquisition reform advances, and worldwide emerging threats become apparent, the need is obvious for a strong industrial base to maintain our economic and military strength and retain our position of global leadership in the 21<sup>st</sup> century. It also becomes clear that our success depends on integrating the civil and military sides of industry. We need only change the rules to find that solution.

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## **ACKER AWARD**

The David D. Acker "Skill in Communication" award, is bestowed in the memory and honor of the late David D. Acker. Mr. Acker was a professor, researcher, historian, archivist, and DSMC's most prolific writer. From 1973 until his retirement in 1991, he produced over 175 papers, magazine articles and books including *History of DSMC*, several editions of the ever-popular book *Skill in Communication*, and his final book *Acquiring Defense Systems*.

The Acker award was first presented at the 1993 Acquisition Research Symposium to recognize and encourage excellence in the exchange of information in the field of acquisition research. Subject matter experts review each paper submission to determine if they meet the criteria established for inclusion in the biennial Symposium and if they qualify for the Acker award. Final award selection is determined by the Symposium Co-Chairpersons.

In continuing with that tradition, this year three of the more than 80 papers submitted for consideration in the 1999 Acquisition Research Symposium received the Acker award. Those papers are contained in this issue of the *ARQ*.

"Purchasing Performance: A Public  
Versus Private Sector Comparison of  
Commodity Buying"

Major Joseph Besselman (USAF)  
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"Paving the Way for Price Based  
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## ACQUISITION RESEARCH SYMPOSIUM

The 1999 Acquisition Research Symposium was the eighteenth in a series of conferences that began in 1972. These Symposia offer a dynamic forum for dialogue among key professionals working on vital issues facing the changing acquisition community. Typical **Acquisition Research Symposium** attendees, both national and international, include senior officials, program managers, staff officers and researchers/acquisition professionals from the Department of Defense, federal civilian agencies, military, academe, and industry.

This year's theme ("**Acquisition for the Future: Imagination, Innovation and Implementation,**") and sub-theme ("**Acquisition Reform: A Revolution in Business Affairs**") reflects the future and continued innovation and implementation in the acquisition process. **Civil/Military Integration** was an area of special focus.

The papers selected for inclusion at this year's Symposium included the latest research and development as documented by individuals involved in the many aspects of the acquisition process. With imagination and innovation, these papers discussed the implementation of new and exciting ideas all in the name of acquisition reform—looking at ways to provide better, faster and cheaper products and services throughout the acquisition community. *The views expressed were those of the authors and do not necessarily reflect the views of the organization with which they are associated, or the views of the Symposium sponsor and hosts.*

These Symposia are biennial events, with the next one scheduled for June 2001. Information on tentative dates and locations, along with calls for abstracts and papers can be found on our HomePage at [www.dsmc.dsm.mil](http://www.dsmc.dsm.mil).

# **PURCHASING PERFORMANCE: A PUBLIC VERSUS PRIVATE SECTOR COMPARISON OF COMMODITY BUYING**

***Maj Joseph Besselman, USAF, Ashish Arora, and Patrick Larkey***

Hard evidence is needed to provide an accurate gauge of DoD spending efficiency. This study compares DoD and commercial spending on specific items, shows that DoD spends significantly less than its commercial counterparts on similar items. These findings question the widely-held beliefs about the inherent inferiority and inefficiency of DoD purchasing and acquisition. The findings also argue for much more careful research on purchasing and acquisition, so that the likely effects of reforms are known.

**P**urported failures in purchasing and acquisition are an important basis for the general public's beliefs that the Department of Defense (DoD) makes inefficient use of tax dollars. A widely publicized string of stories over the past several decades has given the public ample material to compare with private sector purchasing, and to conclude that DoD has been reckless with public money.

We set out to test the validity of the public's beliefs about the DoD by comparing the efficiency of defense purchasing with that of the commercial sector. This research compares the purchases of identical commodities drawn from

electrical, engine, and software sectors. The comparisons consider the price of a good, purchase quantity, relevant contextual information, and DoD's direct buying costs.

The main research questions were:

- What are the differences in buying performance between the commercial and DoD sectors?
- What causes the differences?
- Is there systematic evidence to support the public's beliefs?

The samples of purchases consist of more than 831,000 items purchased as part of 693 actual contracts or delivery orders valued at \$99.9 million to DoD. Among the findings, based on samples of purchases of identical commodities vastly larger than any sample in the literature and improved comparison methodologies, are, first, that DoD pays 41.5 percent less than the average commercial sector organization purchasing the commodities included in the samples. In addition, superior DoD buying performance holds even when considering DoD's direct buying and oversight costs.

### **PUBLIC PERCEPTION AND PAST RESEARCH**

Students of defense procurement, as well as the typical citizen who occasionally reads a newspaper or watches the evening news, agree on one thing: The DoD is an inept buyer of goods and services. Thompson (1992-93), for example, observes the conventional wisdom holds that DoD buying is riddled with fraud and abuse, with overcharging, payroll padding, misappropriation of government property, bribery, kickbacks, and conflicts of interest as commonplace occurrences. The media, and to a much lesser extent the academic literature, have provided many examples fostering these beliefs: \$436 hammers (Comeau, 1984), jet engines purchased by DoD without warranty at a price 20 percent higher than the same commercial sector engines under warranty (Rich and Janos, 1994), \$7,000 videotape recorders (Gansler, 1978), \$7,600 coffee pots, and \$9,600 allen wrenches (Comeau, 1984).

So prevalent are these views that DoD's inspector general, Eleanor Hill, said she

would eliminate the buying of \$436 hammers during her August 28, 1995, swearing-in ceremony, more than 10 years after the hammer purchase made newspaper headlines across the country. Although these examples relate to defense procurement, Downs and Larkey (1986) showed more generally that people believe the U.S. government is inefficient, ineffective, wasteful, and venal, and that its employees are overpaid and underworked.

The belief that DoD is an inept or corrupt buyer rests on a fragile bed of anecdotal evidence. No systematic studies have been performed comparing the buying performance between the defense and commercial sectors using a large sample of purchases of identical commodities. It is unclear whether the aforementioned anecdotes are the rule or exceptions, or whether extenuating circumstances exist to explain the differences in price paid for goods.

Typically, the literature has employed anecdotes focusing only on differences in price while ignoring purchase volumes, representativeness of a purchase, comparability, contextual information surrounding a purchase, or allegedly costly DoD oversight and procurement practices (Mandel, 1977; Michelli, 1977; Angier, White, and Horowitz, 1979; Stimson and Barnett, 1980; Gansler, 1982; Comeau, 1984; Stewart, 1986; "DoD's Inadequate Use" [Senate report 101-62], 1989; the Center for Strategic and International Studies (CSIS), 1991; and Coopers & Lybrand/TASC, 1994). A fuller critical review of this literature is given by Besselman (1998).

The Coopers & Lybrand/TASC study (1994), commissioned by former Secretary of Defense William Perry as one basis

for commercialization reforms, is a recent, important example of the sort of anecdotal research in this area. This study focused on the costs to the government in purchasing and oversight. This directed search for possible savings in purchasing and oversight concluded that:

- the average DoD regulatory cost premium of 18 percent of value-added costs;
- electronics and communications firms appear to have the highest exposure, with an average DoD regulatory cost premium of 25 percent; and
- the DoD acquisition environment imposes substantially greater compliance costs on contractors who develop and manufacture products based on unique military designs.

Unfortunately, the study did not examine possible benefits to the government derived from purchasing and oversight costs. The question never asked or addressed was: Are the government's purchasing and oversight costs justified (that is, more than offset) by lower prices paid than would have been paid absent the costs? Also, the study provided no evidence on best purchasing and oversight practices because it did not examine the practices (and costs) of commercial entities or other units of government.

Even with this restricted cost focus, the methodology was unnecessarily weak. The researchers examined only 10 of the hundreds of possible purchasing sites and the rationale for the 10 selected was not strong. And with this small sample of sites, the researchers relied on opinions of

managers of defense products as data rather than other empirical evidence on actual buying behavior that was readily available. The researchers chose to stay with product lines that were either defense or a mix of defense and commercial business, even though all 10 sites had parallel commercial operations either on or off premises. These strictly commercial operations offered a counterfactual basis of comparison, a means of validating the opinions from cost center managers of defense projects.

These problems are symptomatic of the more general problem of a lack of scholarly research in the defense policy sector, including defense acquisition (Walt, 1991; Mayer and Khademian, 1994). The problems with the defense procurement literature can be likened to the more general problem of understanding organizations as identified by March and Simon (1958)

**"These problems are symptomatic of the more general problem of a lack of scholarly research in the defense policy sector, including defense acquisition."**

40 years ago:

"The literature contains many assertions, but little evidence to determine—by the usual scientific standards of public testability and reproducibility—whether these assertions really hold up in the world of fact."

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## **GAUGING EFFICIENCY**

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Understanding the relative efficiency of defense procurement and how it might be reformed is an important public policy

issue. The DoD purchases more goods and services than any other organization in the world, with 8.7 million contracts worth more than \$132 billion in goods and services (in 1996). Of the 8.7 million contracts, 8.3 million were for goods and services contracts, primarily standard items worth less than \$25,000, with a total value of \$12.4 billion. Approximately 275,000 of the 8.7 million contracts were large system or commodity contracts worth more than \$25,000 for a total value of \$109 billion. With this high volume of buying, even if DoD could achieve six sigma quality,<sup>1</sup> the holy grail of manufacturing quality, DoD would still face approximately five to eight procurement disasters per year.

But funding for procurement is declining, since the Cold War is no longer a driving force for increased defense spending. As the budget falls, so does the size of the military forces, as well as the number of civilians that support the military in criti-

**"Reductions in personnel and procurement funding must be accompanied by process changes to enable DoD to function effectively."**

cal acquisition or purchasing positions. Reductions in personnel and procurement funding must be accompanied by process changes to enable DoD to

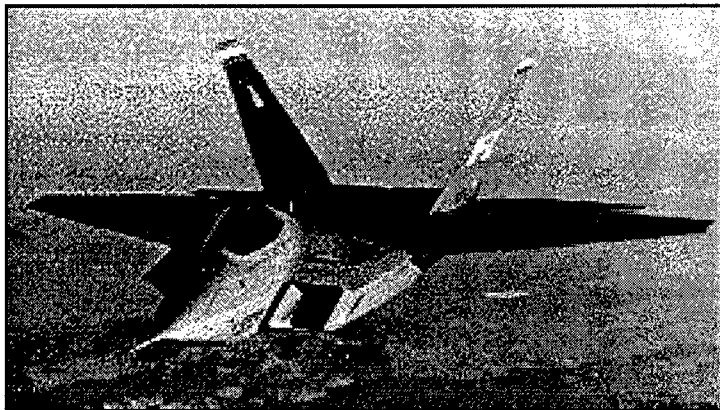
function effectively. The Congress and the President have been ambitious in their efforts to reform DoD's buying practices and make it easier to buy commercial items through the passage of the Federal Acquisition Streamlining Act of 1994 (Heberling and Houpt, 1995) and the Federal Acquisition Reform Act of 1996

(FARA). The enormous sums of money coupled with the declining budget highlight the importance of understanding the effectiveness of defense procurement practices before offering further reforms.

### **WHAT ARE THE DIFFERENCES IN BUYING PERFORMANCE?**

Rational procurement reform must be grounded in concrete knowledge of what DoD pays relative to the commercial sector for equivalent goods. Not only is this important from a public policy perspective, but this level of insight would enable DoD's purchasing organizations to measure and then continuously improve their operations. Generalizing as to whether DoD pays more than the commercial sector for an equivalent good is not a trivial task. The DoD is not a monolithic organization with one procurement style purchasing one type of good with a singular cost structure. The goods purchased by DoD range from simple commodities, such as hammers, bolts, or transistors, to highly complex unprecedented systems, such as the Air Force's newest fighter, the F-22. To ensure that identical goods are being compared, this research focuses on commodities. As more complex DoD goods are examined, it becomes increasingly more difficult to find identical commercial counterparts. For example, no commercial counterpart exists for the Air Force's F-22 fighter or B-2 bomber. There are commercially available commodities purchased for or in support of those aircraft, however.

It is not easy to gather a large sample of actual, identical commodity purchases, gain government or commercial sector

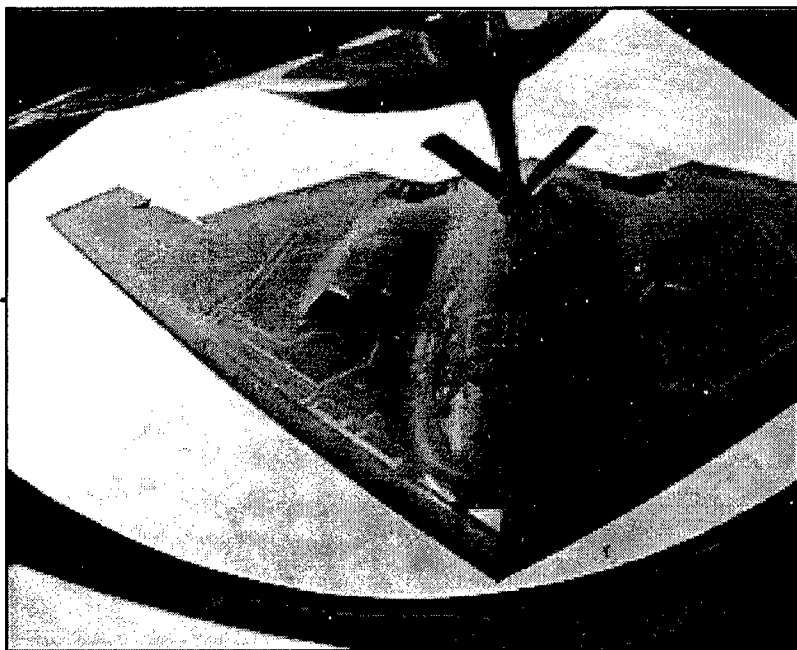


**The goods purchased by DoD range from simple commodities, such as hammers, bolts, or transistors, to highly complex unprecedented systems, such as the Air Force's newest fighter, the F-22.**

cooperation, and determine a fair basis of comparison. First, government buying personnel have myriad abstruse rules and procedures they must follow to purchase many items. Second, videotape recorders for a military jet aircraft, as an example, are not the same as those a consumer buys at a local discount store. Third, media exploitation of past anecdotes of alleged

incompetent government buying has created an atmosphere of fear that translates into a general unwillingness to take part in this genre of research. Fourth, some commercial entities are reluctant to cooperate because they believe data describing their sales behavior has proprietary value.

**No commercial counterpart exists for the Air Force's B-2 bomber.**



## SELECTION OF COMMODITIES

The vast majority of DoD's purchases are for commodities. The data samples collected for this analysis come from two sources: DoD's buying centers and firms that have sold common products to both markets. The comparisons consist not only

**"One could argue that government buyers are capable of skewing the data collection process in order to look good to some researcher."**

of price differences, but also the total dollar value of each purchase along with the relevant factors identified in the previous section. The selection of com-

modities for comparison is a balancing act between data availability, reliability, comparability, and confidentiality.

To collect data on commodity purchasing, we questioned low-level suppliers and collected random samples from the Defense Logistics Agency (DLA) and various DoD maintenance and buying centers. The DLA does some bulk purchasing, whereas the logistics centers buy parts and equipment specific to their mission. For example, at the time the engine sample was collected, Kelly Air Force Base, in San Antonio, TX, was the logistics center for engine overhaul for the Air Force and some Navy aircraft, and it bought many of the engine-related parts used by DoD.

Three sectors were targeted for data collection: electronics, engine, and commercial-off-the-shelf (COTS) software components. Many goods from the electronics and engine sectors are common to DoD and commercial buyers. The DoD is a minor buyer in the electronics sector and a major buyer in the engine sector. In the

COTS software market, DoD is a large buyer, but its purchases are dwarfed by the much larger overall commercial market.

## DATA AVAILABILITY

Despite the existence of a commodity purchased by both sectors, the data may not be available for comparison. There is no master procurement list detailing the population of commodities purchased by both sectors. One must research the variety of commodities purchased by DoD, identify the buying activity for a particular sector, and then receive permission to collect a sample of purchases. We contacted government buying entities and interviewed them to determine how to identify and arrive at a sample of commodities sold in both sectors.

On the commercial side, collecting purchase information is even more of a challenge because rarely is pricing information readily available. For example, thousands of suppliers provision DoD in the electronics sector. To get a picture of their pricing behavior in the commercial sector, one must contact the firms individually and solicit their cooperation in providing this information. On the DoD side it is much easier, because there is typically one or a few buyers within a particular sector. The relationship is one DoD buyer to many commercial suppliers.

## DATA RELIABILITY

Another challenge is the reliability of the data gathered, given distrust on the part of government personnel, timeliness, or whether the record of a purchase still exists months after it has transpired. One could argue that government buyers are capable of skewing the data collection

process in order to look good to some researcher. This risk can be mitigated by looking firsthand at the contracts within a sector as part of the data collection process. All of the data in this analysis was collected in this manner except for the electronics sector. The possibility that multiple buying organizations would fabricate contract files to fool a researcher is remote. Furthermore, some of the purchases were corroborated by evidence from the actual firms. In the case of the electronics sector data, the commodity purchases were provided from a pool of commercial buys for which the depot had complete data.

It is also conceivable that depot personnel selected purchases that reflected well on the government compared to the commercial sector, and then claimed that they lacked data on other purchases. But there really is no way the government personnel could have determined what was a good buy and what was a bad buy. How would they have written a computer program to collect only commercial commodity buys in which the government was the best buyer? Commercial pricing data does not exist in their system, and they certainly did not have time to call vendors and add such data in the span of time between the initial contact and the visit to their depot. Furthermore, the low-level contracting and programming personnel that provided the data and background discussions, following introductory meetings with the depot's senior management, were stunned that a researcher was even being allowed to pursue such research. They were stunned because they expected any such study to portray them as poor buyers of commodities, so conditioned were they by the media and DoD leaders to believe it must be so.

The time interval between the time the data was collected from the depot and the commercial organizations were contacted could affect the reliability of the electronics data. This interval was always 3- to 12-months and not all commercial organizations kept pricing material even that old, so some commodity purchases were omitted. Another side of the problem was DoD's very own data. Although the depot's personnel claimed the size of the problem as very small, some of the commercial purchases were missing key pieces of data. The depot's programming representative said this was an attribute of the depot's conversion of historically military items to

strictly commercial classification. During 1995, the depot was systematically reclassifying those parts

in its inventory of commodities that could be satisfied by a purely commercial part. The data migration process was not perfect and introduced what is commonly referred to in the information technology sector as "dirty data": records with either missing or incorrect data.

**"The refusal of some firms and DoD organizations raises the specter of bias."**

#### **DATA COMPARABILITY**

Another problem with comparing commercial and DoD prices is determining the fair basis of comparison. Should retail or wholesale prices be used? Where possible, both retail and wholesale prices were gathered for a commodity. In the absence of such pricing practices, we used pricing based on lot size. Under those circumstances, the smallest salable lot size is assumed to be the retail price. The wholesale price is then

assumed to be either the price commercial firms pay when buying in lot sizes equivalent to those DoD buys, or the price commercial firms pay when buying in their typical lot sizes. The analyses of the commodity data take into consideration the different price bases. Although some results of comparisons of DoD to retail prices are provided, this research focuses primarily on DoD performance compared to the average commercial sector organization, where the average commercial sector organization is buying at commercial wholesale prices.

**"Treating various facets of the analysis as confidential is a common feature of this kind of research."**

### CONFIDENTIALITY

Most DoD organizations and commercial firms taking part in this research are not identified. Furthermore, specific products and prices will also not be identified. Confidentiality is essential for gaining access to procurement information, particularly for a buying activity or manufacturer who understands that their practices and outcomes may be embarrassing to their organization or provide a competitor insight into their proprietary pricing practices. With the power of computers, it is trivial for an auditor to identify a manufacturer or DoD buying activity perceived to be overcharging DoD or shirking their responsibilities. DoD agencies and their contracting firms, in general, are extremely sensitive to public disclosure of any information that may embarrass the respective agency. Despite

assurances of confidentiality, many firms and, initially, a few DoD organizations were reluctant to participate in this research.

The refusal of some firms and DoD organizations raises the specter of bias. Is it possible that DoD will appear better in this analysis because the poorly performing organizations refused to participate? Yes, the possibility exists, but experience with the data collected as part of this research points in the opposite direction. First, eventually all DoD firms asked to participate ended up participating to some degree, some more reluctantly than others.

Second, for the aforementioned question to be true, one would expect that all of the participating buying activities would consider themselves as good organizations outperforming the commercial sector. Although in nearly every case there was enormous pride on the part of DoD buyers and genuine belief that they were doing their best for the taxpayer, despite any direct contrary evidence bearing on their efforts, they felt sure the commercial sector was doing a better job. The phenomenon is a lot like the child who, after being repeatedly told by his parents and teachers that he is stupid, begins to believe it even though he is faced with a wealth of contrary evidence. The buyers had no specific evidence they were doing poorly, but they had been conditioned by the media, national leaders, and DoD's own leadership to believe the worst.

Third, of the firms that did not participate, the vast majority of the affected dollars from the discarded contracts point to DoD being the better buyer. For example, approximately \$350,000 over seven contracts in the electronics sample was excluded because a broker that sells

these particular products as a retailer is prevented legally from providing the price it pays to the manufacturer. The manufacturer explained that it was legally bound to its brokers not to provide their prices. One broker finally provided a "ballpark" markdown from the list price for the range of products, which was significantly above the price charged DoD by the manufacturer. Since the broker did not provide the individual markdowns, those purchases were discarded entirely. Collectively, they constituted about 10 percent of the total value of the electronics sample and would have enhanced DoD's purchasing position relative to the commercial sector.

Treating various facets of the analysis as confidential is a common feature of this kind of research. The jobs and careers of DoD buying and selling personnel could be adversely affected if unfavorable information is brought to the public's or a competitor's attention. Past research produced by Peck and Scherer (1962), the seminal work on defense procurement, Gansler (1982), the CSIS (1991), and the Coopers & Lybrand/TASC (1994) study all contained aspects of confidentiality in order for the researchers to secure, analyze, and publish vital information regarding the DoD procurement sector.

Even good news or a success story can sometimes bring unintended consequences to a program or its management. Burton provided an incident from 1980 in which the program manager for the Air Force's A-10 ammunition procurement, Col Bob Dilger, was allegedly fired within hours of briefing much of the Pentagon's Air Force leadership on how he had introduced competition in his procurement and drove down the price of a cannon shell (essentially a commodity) from \$83 to \$13 (Burton, 1993).<sup>2</sup>

## **ANALYSIS APPROACH**

A new method of analysis was used to compare the prices paid by DoD and commercial sectors: weighted price difference analysis. In the past, mere price comparisons or unweighted price difference analysis was the method used by researchers and the media. One never had any conception of whether a showcased part or commodity purchase was representative of DoD buying or an outlier. Unweighted price difference analysis involves subtracting the commercial price from the DoD

price and then dividing the result by the commercial price. This method constrains purchases in DoD's favor between -

100 percent and 0, and purchases in the commercial sector's favor between 0 and infinity; thus, DoD's buying performance is adversely biased relative to the commercial sector.

The weighted price difference methodology weights each purchase price by the proportion of expenditures in the entire sample accounted for by this purchase. This has the effect of making high-dollar-value purchases of greater importance in the analysis. Interestingly, this research uncovered many egregious purchases by DoD, but in nearly every case they were for low-dollar-value items purchased in small quantities. Once those low-dollar-value purchases were weighted, their importance in the overall analysis waned. As the product of purchase quantity and purchase price increased, the relative efficiency of DoD's purchasing also increased.

**"A new method of analysis was used to compare the prices paid by DoD and commercial sectors: weighted price difference analysis."**

A third analysis approach, percent difference, aggregates all purchases at DoD and commercial prices to arrive at the dollar totals. The calculation is to first compute the ratio of total commercial to DoD buying cost and then subtract one to arrive at the relative efficiency. This method, equivalent to a price index using DoD quantities as weights, compares the DoD cost to purchase all of the goods in a sample to the commercial wholesale cost to purchase the same goods.

## ANALYSIS

Weighted price difference analysis between the commercial wholesale and DoD sectors reveals DoD's buying is 5.9, 47.4, and 34.2 percent more effective within the electronic, engine, and software commodity samples, respectively. A *t*-test revealed that each mean was statistically different from zero ( $p < .001$ ). The electronic, engine, and software commodity samples comprised 329, 132, and 232 purchases or delivery orders valued at \$2.7, \$60.9, and \$36.3 million using

DoD's actual unit prices. The largest sample presently found in the literature consists of 40 purchases (Angier, White, and Horowitz, 1979). Even at the macro-level of the sample, this research shows that as the average dollar value of an electronic, engine, or software purchase increased, so did DoD's relative buying efficiency. Engine buying significantly outperformed software buying and software buying significantly outperformed electronic buying.

Aggregate analysis of DoD's purchasing performance was no different. Overall, weighted price difference analysis reveals that DoD outperformed the average commercial sector organization using commercial wholesale prices by 41.5 percent. Table 1 summarizes these findings with the findings from each sector. In every case, DoD's total sample cost was less than if commercial wholesale prices had been used (see the "percent difference" column of Table 1). When those same price differences are not weighted (see the "unweighted" column of Table 1), where each purchase is of equal value in the analysis, DoD pays 20.7 percent more than

**Table 1.**  
**Summary of DoD Purchasing Performance and Costs by Sector**

|                                                                  | Price Analysis Summary <sup>a</sup> |            |          | Value of Purchases <sup>b</sup>      |           |        |
|------------------------------------------------------------------|-------------------------------------|------------|----------|--------------------------------------|-----------|--------|
|                                                                  | % Difference                        | Unweighted | Weighted | DoD Cost                             | Wholesale | Retail |
| Electronic                                                       | -14.4                               | 70.2       | -5.9     | 2.7                                  | 3.1       | 4      |
| Software                                                         | -66.5                               | -19.7      | -34.2    | 36.3                                 | 60.5      | 88.4   |
| Engine                                                           | -105.5                              | -31.7      | -47.4    | 60.9                                 | 125.1     | 178.1  |
| Total                                                            | -89                                 | 20.7       | -41.5    | 99.9                                 | 188.7     | 270.5  |
| <sup>a</sup> Percentages using the three price analysis methods. |                                     |            |          | <sup>b</sup> In millions of dollars. |           |        |

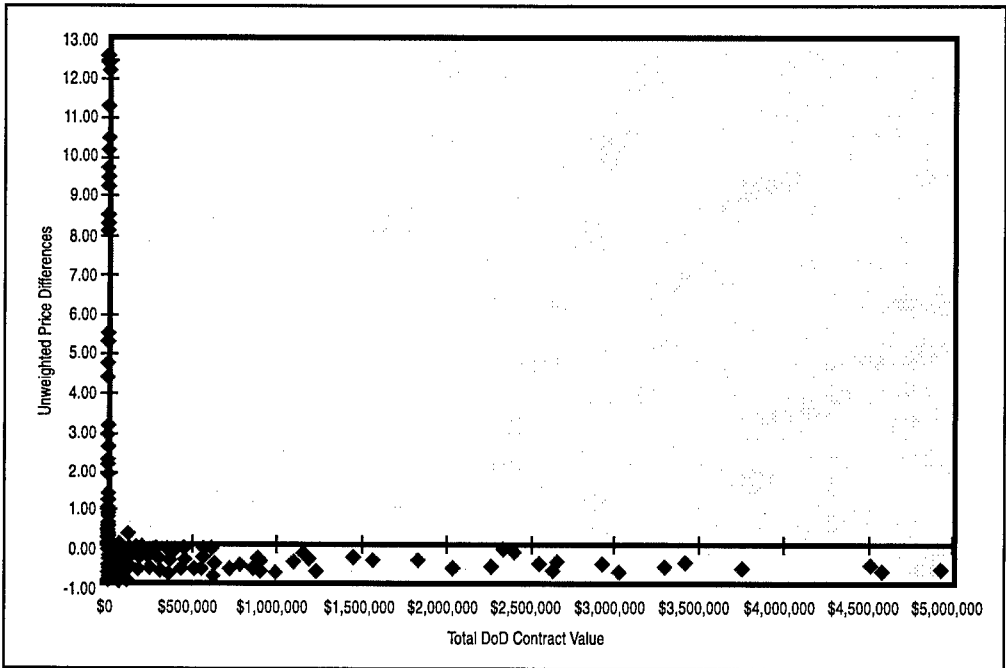


**Figure 1. Scatterplot of All Purchases by Total DoD Contract Value Versus Unweighted Price Differences**

the average commercial sector organization. Collectively, DoD paid \$99.9 million for the more than 831,000 items that constituted these samples. Using commercial wholesale prices, the average commercial sector firm would have paid \$188.7 million for the very same commodities.

These findings cogently capture the flaw in comparing unweighted price differences. Examining only price differences distorts DoD's actual buying behavior because it does not consider the total dollar value of a purchase. Furthermore, many of the individual purchases contributing to the perceived poor DoD buying performance would make good anecdotes for the evening news or a tabloid article. A more realistic assessment of DoD's buying performance is found by weighting the purchases according to purchase volume,

revealing that (within the samples gathered as part of this research) DoD outperforms the average commercial sector organization when purchasing commodities.

The DoD's aggregate buying behavior is captured graphically by plotting all of the purchases based upon the unweighted price difference and total DoD contract value of each purchase. In terms of total DoD cost, the purchases range from less than a dollar all the way up to approximately \$5 million. The range of unweighted price differences begin at just more than -100 percent and climb to more than 1200 percent. All of the purchases are plotted in Figure 1. The scatterplot reveals that the vast majority of purchases are in DoD's favor, falling in the 0- to -100-percent range in terms of unweighted price difference. The scatterplot also highlights the

distortion in the unweighted price difference method. The scatterplot reveals more than a dozen purchases in which DoD paid more than 500 percent above commercial sector prices, yet those purchases were for trivial amounts. The figure shows that as the total value of a purchase increases, the buying performance of DoD is better than the average commercial sector organization buying at wholesale prices.

This research was also innovative in factoring DoD's oversight costs into the total cost equation in order to more accurately evaluate DoD's relative efficiency.

**"As the total dollar value of a purchase increases, so does DoD's attention and effort for getting a fair price."**

All of the personnel associated with the purchase of the engine parts and software commodities were identified and their labor

costs computed. In nearly every case these individuals either supported other engine purchases or other activities beside software purchasing.

Two case studies from the engine and software commodity sectors considered all DoD purchasing costs and assumed the commercial sector's buying costs were zero. Despite this handicap, DoD outperformed the average commercial sector firm buying at commercial wholesale prices. For example, DoD paid \$59.3 million for 71 engine part contracts while accruing an estimated \$8.3 million in labor costs. The total cost to DoD is \$67.6 million. However, if the manufacturer's best commercial customer purchased those same parts and purchased them while accruing no labor costs, they would have paid \$123 million. For the software

sample, DoD paid \$36.4 million for the purchases constituting the sample and incurred an estimated \$3.9 million in labor and contract costs to research and purchase the software commodities. The average commercial sector firm receiving wholesale prices, however, would have spent \$60.5 million for the very same software products. Even when DoD's purchasing costs are considered, DoD outperforms the average commercial sector organization buying at wholesale prices.

### **WHAT CAUSES THE DIFFERENCES IN BUYING PERFORMANCE?**

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DoD's buying behavior can be compared to that of the typical American consumer: As the total dollar value of a purchase increases, so does DoD's attention and effort for getting a fair price. If the typical consumer needs only a loaf of bread or gallon of milk, he or she will more often than not purchase it at the nearest convenience store even though a grocery store offers a lower price. But if the consumer has a long list of items to buy or it is the weekly shopping trip, he or she will undoubtedly go to the local grocery store or discount warehouse for its better prices. On high-cost purchases such as automobiles, houses, and appliances, the typical consumer is more likely to thoroughly research sources and comparison shop. The DoD buyer is no different in allocating attention and effort in purchasing.

Like a typical consumer, a variety of practices are employed by DoD in order to achieve superior performance relative to the average commercial sector firm. First, DoD acts according to legislation

passed to ensure that it pays no more for an item than any other commercial sector firm buying under similar circumstances, although this statute is rarely enforced. Second, for high-dollar-value purchases, most DoD buyers appear to study their suppliers, aggregate their buys, watch for sales, forecast, and negotiate aggressively with suppliers. In the software sector, studying suppliers, aggregating requirements, and waiting for sales provided deep savings; the deepest discounts were often offered by a commercial supplier at the close of a financial reporting period. Aggregating buys is one method DoD uses to exploit its buying power.

Forecasting is important if DoD expects to derive the benefits of "just in time" delivery and aggregating buys to get the greatest quantity-based price breaks. With effective forecasting, DoD can then enter into long-term contracts with a supplier to provide incremental quantities on a monthly basis over several years. This provides a win-win situation for DoD and suppliers. This is precisely how information distortion in a supply chain can be eliminated, and thus lead to the greatest efficiencies for both the supplier and customer (Lee, Padmanabhan, and Whang; 1997). With good forecasting information for the DoD buyer and his supplier complemented by long-term contracts with incremental deliveries, the supplier-customer team is managing throughput rather than speed; it is effective throughput management that minimizes cost (Fuller, O'Connor, and Rawlinson, 1993). The DoD is able to glean the benefits of a high-quantity buy while accruing savings from reduced inventory. The supplier is able to more effectively plan its production and minimize its inventory

of raw materials. This is, however, an area ripe for process improvement across DoD, since all product lines are not effectively forecasting demands or future requirements.

Third, DoD has the option of collecting cost and pricing data on purchases for which no real commercial market exists, if the purchase is over \$500,000, or to support a sole source purchase of some kind (where competition is not used even though alternative suppliers may exist).

Collecting cost and pricing data is another example of DoD exercising its buying power. Cost and pricing data provides visibility

**"It costs DoD money in terms of buying personnel and on-site labor to collect cost and pricing data."**

into a manufacturer's production costs. It costs DoD money in terms of buying personnel and on-site labor to collect cost and pricing data. Ironically, the acquisition reform movement succeeded in making it more difficult for DoD to collect cost and pricing data with FARA of 1996. The irony lies in the DoD leadership's perception of what is and what will continue to be a commercial practice: collecting cost and pricing data (Vander Schaaf testimony, 1995).

Large firms with substantial buying power in a market have collected cost and pricing data long before DoD ever entertained the idea. Perrow (1970) has shown that large organizations that possess power over subordinate suppliers regularly audit their records (and cites Ford Motor Company as one example). Pfeffer (1978) reinforces this observation of powerful commercial organizations that derive greater profitability from asymmetrical

exchanges with suppliers, using General Motors as one example of a firm that gains visibility into its supplier's operations and

**"We need to pay attention to the big picture: big purchases."**

uses that knowledge to control the price at which it buys. More contemporary research highlights how

firms with market power exercise that power through meticulous understanding of their supplier's costs, with some delving deeply into the supplier's engineering and quality activities (Hardy and Magrath, 1987; Burt, 1989; Myer, 1989; Cross, 1995; and Taylor and Wiggins, 1997). In the food service and retail sectors, McDonald's and Wal-Mart, respectively, as examples, can be seen exercising this kind of leverage over a supplier.

Fourth, DoD will seek secondary sources of supply when they own a set of engineering drawings or when items are available from more than one manufacturer. This drives competition into the purchasing process for parts that are generally not sold in the commercial marketplace. Lastly, for items that are bought and sold in large volumes in the commercial sector and are found on a commercial price list, DoD will often negotiate price breaks off of the commercial list price.

Once the reasons for DoD's superior buying performance are distilled, it is clear the organizational framework first presented by Simon (1947), March and Simon (1958), and then Cyert and March (1963) offers one interpretation of DoD's performance. In terms of purchasing, DoD has several goals it tries to meet across its contracts. For example, DoD undoubtedly wants a good price that pays a fair profit

to its suppliers, but other goals such as support to small businesses and minority-owned firms also enter into the decision process. In order to meet these sometimes conflicting goals, DoD has searched over time and arrived at a set of procedures or heuristics used to ensure all goals are satisfied to the greatest extent possible. The use of cost and pricing data, aggregating buys to leverage market power, or studying one's suppliers are standard operating procedures or heuristics used when buying commodities. Also, DoD has a system of authority and influence in place for purchasing: Most notable is the practice of having contracting officers (rather than program or item managers) awarding contracts. Similarly, only certain contracting officers are allowed to award contracts above certain dollar thresholds. A system of training is in place to cultivate increasing levels of expertise and experience.

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### **IS THERE SYSTEMATIC EVIDENCE TO SUPPORT PUBLIC BELIEFS?**

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This research has provided evidence that calls into question generally held beliefs about government purchasing. The evidence shows that at least in the sectors examined by this research, DoD is clearly doing an effective job purchasing and that its effectiveness increases as the total dollar value of a purchase increases. This finding should cause DoD policy makers to carefully consider how they allocate their valuable labor dollars to ensure effective purchasing. Contrary to claims by DoD Inspector General Eleanor Hill, it may not be in the best interest of the taxpayer that we get the best price on a

few dozen hammers. It is far more important that we ensure, for example, that the several million dollars in turbine blades and vanes for certain engines are bought effectively. We need to pay attention to the big picture: big purchases. Other emerging evidence indicates this is not an institutionalized practice.

The spare parts "scandals" that emerged in congressional testimony on March 18, 1998, provide further support to this research's findings. The data embodied in this research was gathered before the implementation of policy changes associated with FARA. Today, DoD buyers and contracting officers are prevented from collecting certified cost and pricing data on purchases below \$500,000 or on commercial items. The conditions surrounding the purchase of commercial items have changed.

Many in industry have responded to FARA by listing traditionally military or noncompetitive parts in a commercial catalog, calling them commercial items, and offering them for sale to the public—daring government procurement officers to ask for cost information, even if that part has little or no commercial customer base and is found only in militarized systems. These changes have produced many embarrassing purchases by DoD: For example, 108 electrical bells that used to cost \$46.68 are now \$714 (1,430 percent increase); 187 set screws that used to cost \$0.57 are now \$75.60 (a 13,163 percent increase). The fairness and reasonableness of the prices were determined using the cost and pricing data DoD collected only two years ago for those very same parts.

The latest parts scandal highlights the need for careful measurement and the

exercising of judgment in the collection of cost and pricing data. Furthermore, the definition of a commercial item should revert back to its former incarnation, where a commercial item was a product that was sold in significant quantity in the commercial sector. In the past, a contracting officer was also allowed to exercise judgment in the determination of whether an item was truly commercial. The most important irony of this latest pricing flap is that today's operational commanders are paying more for many spare parts than they were two years ago; thus, they will have less to spend tomorrow on the modernization of their weapon systems. It is no surprise that we are now seeing spare parts shortages as budgets fail to procure required numbers. The movement to price-based purchasing of militarized, noncompetitive parts has exacerbated the current spare parts crisis facing our operational units.

**"Exploiting market power is a classic strategy for saving money in both public and private sectors."**

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## **CONCLUSIONS**

Our findings contrast sharply with conventional wisdom and the themes permeating much of the literature on defense procurement. This should cause DoD's leadership to more carefully consider how it intends to make DoD a more efficient buying organization. Leadership needs to more realistically evaluate its push toward a one-size-fits-all public policy as it tries to commercialize its operations to a greater degree. This

research suggests that buying commercial items off commercial price lists will cost the taxpayer more money. Uniformly eliminating in-plant oversight personnel that collect cost and pricing data will adversely affect DoD's purchasing power, for cost and pricing data is a valuable commercial sector tool the DoD buyer should exploit under the appropriate circumstances. The DoD must continue to examine where it has market buying power and then exercise that market power to get the fairest price for the taxpayer. Exploiting market power is a classic strategy for saving money in both public and private sectors (Thompson and Jones, 1994). Certainly within the engine and software commodity sectors DoD carries important buying power ripe for exploitation.

This research provides important measures of efficiency DoD should but does not consistently measure across its buying organizations. For the past 40 years multiple pieces of legislation have been passed with the aim of making

government, including DoD, measure and improve its operations. The DoD should exploit weighted price difference analysis by collecting samples of its purchases annually at each of its buying activities and compare performance to the average commercial sector organization.

If DoD is truly to improve the efficiency of its processes, it needs to analyze how well it is doing today. These analyses need to consider all costs and benefits that feasibly can be gathered. Real cost-benefit analyses will help DoD to identify where it is buying well and determine the right mix of on-site support to help buyers and contracting officers. Then DoD can formulate the kind of strong measurement program needed to truly improve its purchasing processes. Despite numerous calls for reform and commercialization of its activities over the past three decades, DoD's leadership has little understanding of how effective its buying processes are compared to the commercial sector.

#### **DISCLAIMER**

The views expressed in this paper are those of the authors and not the official views of the U.S. Air Force or Carnegie Mellon University.



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**ENDNOTES**

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1. Six sigma quality implies that the product is of such high quality that the defect rate can be measured using a single digit per one million items manufactured.
2. The A-10 Warthog is the tank-killing aircraft that was the big success story of the Gulf War. Colonel Dilger's success was a source of embarrassment.

Colonel Dilger was a fighter pilot and not a graduate of any of the Air Force's procurement schools, yet he managed to drive down costs and return unneeded production funding back to the Air Force. In the sometimes perverse world of DoD procurement, the "inability" to use all of one's allocated funding is taken as a sign of poor management rather than efficiency.

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# THE ROLE AND NATURE OF ANTI-TAMPER TECHNIQUES IN U.S. DEFENSE ACQUISITION

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Military technology can be compromised following foreign sales to an ally, accidental loss, or capture during a conflict by an enemy. Because U.S. military hardware and software have a high technical content that provides a qualitative edge, protection of this technological superiority is a high priority. Program managers can mitigate such risks with a relatively new set of technologies inclusively known as "anti-tamper." Program managers need to know the state of the art in anti-tamper technology and of the emerging DoD and U.S. Air Force policy on its use. This article covers anti-tamper policies; explains how, where, and when to insert these technologies; and describes some anti-tamper technologies now in use.

**A**t a time of some future conflict The Ops Center was alive with the buzz created from the most recent news flash. The first loss in the war of a Banshee UCAV (uninhabited combat air vehicle) was causing a bit of consternation. The loss itself was unfortunate enough, although some were taking solace from the fact that it didn't come about as a result of enemy fire. Instead, a failure of some sort—likely an engine malfunction—had resulted in the aircraft going down while on a deep strike escort mission.

While the continued conduct of the strike occupied the thoughts and energy of most in the room, a small contingent was crowded around a screen where the latest overhead imagery was being displayed. The initial reaction was one of surprise and then muted murmurings. If the imagery was to be believed, it was showing that the aircraft had survived the resulting crash in rather good condition. Although most of the nose and control surfaces were damaged beyond repair, the fuselage itself was fairly intact. One side-

bay weapons door appeared to be flung to the side and there on the ground in full view was an advanced AIM-172 air-to-air missile. And apparently it was undamaged!

This new missile variant had been developed in response to the latest electronic countermeasures (ECM) deployed on the enemy's fighters and now it appeared he was going to gain access to the missile intact. While the new missile's capabilities against ECM were judged very effective, they were considered "fragile" because they depended heavily on special software algorithms contained in the missile's processor. If the enemy were able to recover the processor and download the operational flight program (OFP) containing these algorithms, then as everyone knew, his ECM system could be easily updated to defeat the missile. The air superiority that had been gained over the past few days of the war would be jeopardized very quickly....

While this scenario at first blush might appear to be the stuff of science fiction, it is a vital concern today. The loss or compromise of critical U.S. technologies is a constant threat and one that our operational forces take very seriously. Unfortunately, protection of our weapon systems through inherent design has not been the standard practice for industry weapons makers nor of their government partners, that is, our fellow acquisition program managers. However, changes in technology, in the military and political environments, and in defense acquisition policies favor an approach to weapons systems development that addresses this potential weakness. The name for this new approach is "anti-tamper."

## **WHAT IS ANTI-TAMPER? WHY HAVE IT?**

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Anti-tamper (AT) is defined as the systems engineering activities intended to prevent or delay exploitation of essential or critical technologies in U.S. weapon systems. According to Department of Defense (DoD) 5200.1-M, an essential or critical technology is one that "if compromised would degrade combat effectiveness, shorten the expected combat-effective life of the system, or significantly alter program direction." Access to such information could force undesirable changes to tactics and concepts of operations (conops), premature retirement of a weapons system, or major system design changes to regain some level of effectiveness.

The use of AT protective techniques will vary depending on the technology being protected. For example, state-of-the-art technology of a critical nature typically requires more sophisticated AT applications. Some examples of AT techniques include software encryption, integrated circuit protective coatings, and hardware access denial systems.

Until most recently, documented U.S. defense policies say little specifically about AT. Accordingly, there has been limited motivation for, knowledge of, or enthusiasm by program managers to incorporate AT techniques into the weapon systems whose development they oversee.

We believe, however, that even without specific language mandating the use of AT techniques, the direction that has existed provides ample reason for program managers to consider incorporating them. For an example of such direction we need look no further than DoD 5200.1-M,

which says in part that program managers are to "selectively and effectively apply security countermeasures to protect essential technology." The manual emphasizes that such countermeasures are "required to prevent foreign intelligence collection and unauthorized disclosure of essential program information, technology, and/or systems." Furthermore, this protection is "mandatory for use by all of the DoD components."

Now one might argue that the manual's original intent in making these statements was solely to focus our community on the importance of developing a robust program protection plan that affords adequate acquisition program protection. The program protection plan defines and refines a system security baseline for the implementation of security countermeasures and to man-age security costs as well as risks through-out the life cycle of the system. Program protection planning provides program managers, system managers, and users with an overall view of system-specific threats.

Traditionally, the program protection plan has been interpreted to mean a set of processes and infrastructure that guard or limits the exposure of information about critical technologies or operational employment schemes during the development and initial fielding phases of a system's life cycle. Such a perspective is true enough, but incomplete. It fails to recognize the cradle-to-grave perspective that acquisition personnel are to take when developing a new weapon system and sustaining it.

As defined by DoD 5200.1-M, acquisition program protection "integrates all security disciplines, counterintelligence, and other defensive methods to deny

foreign collection efforts and prevent unauthorized disclosure to deliver to our forces uncompromised combat effectiveness *over the life expectancy of the system*" (emphasis added). Obviously, from this last statement, it is clear that protection of critical technologies extends well into the deployment phase of a weapon system and even unto its retirement. Thus, we argue that a broader interpretation of DoD guidance is perfectly legitimate and within the spirit and intent of the originators of these directives. Despite these arguments, it is clear from the current situation that such an interpretation does not flow down into program development strategies.

**"Some examples of AT techniques include software encryption, integrated circuit protective coatings, and hardware access denial systems."**

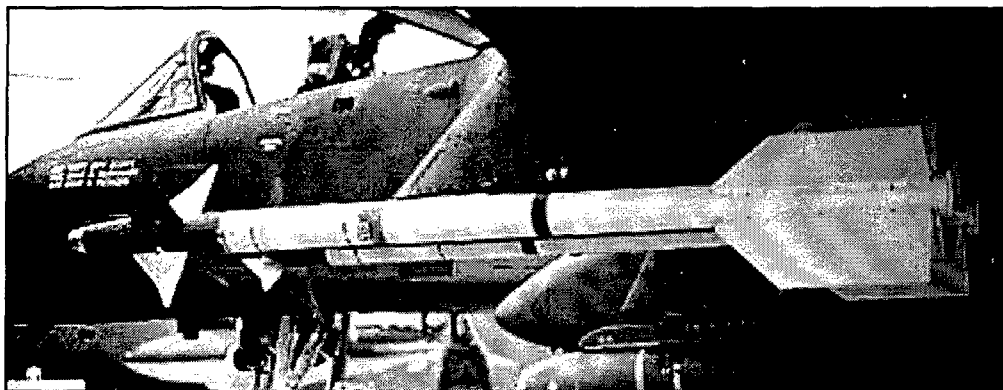
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### **WHY EMPHASIZE ANTI-TAMPER NOW?**

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The primary goal of AT techniques is to protect the combat advantage of the U.S. warfighter. This goal is accomplished by inhibiting exploitation and the development of countermeasures against critical U.S. technologies.

Within the past few years, U.S. policy has strongly encouraged the sale or transfer of certain military equipment to allied and friendly foreign governments. Increasingly, this equipment contains the latest in U.S. technological advances. Whereas in the past, U.S. policy has been relatively reluctant to permit such sales, the current cost-conscious environment motivates the



**The introduction of the AIM-9 air-to-air missile provided a performance advantage that far exceeded its U.S. designers' expectations.**

leveraging of reduced unit prices that is afforded by increased production quantities. Additionally, the DoD is seeking increased foreign participation in acquisition programs from the requirements definition phase through production, fielding, and life-cycle management. While these efforts have the potential to enhance interoperability, standardization, and commonality, reduce unit costs, and strengthen U.S. industry, they also risk making critical U.S. technologies vulnerable to possible exploitation.

Another threat that increases the opportunities for exploitation is the increased exposure of U.S. weapons and the technologies they contain during contingency operations. As has been widely reported, U.S. forces are now deploying abroad at a much higher rate than at any time during the Cold War. Invariably, as was demonstrated by the shootdown of Capt Scott O'Grady, military systems will be lost in battle or by accident. There is no guarantee that such losses will be mitigated by damage to the equipment and in most



**The Soviets were able to acquire the AIM-9 air-to-air missile technology and quickly reverse-engineer it into an AIM-9 clone.**

cases we must make the assumption that such systems have been compromised.

Lastly, the threat of espionage has not withered with the demise of the former Soviet Union. In fact, the "rainbow threat" makes counter-espionage activities even more difficult today than during the Cold War. Still, our experiences during that period provide ample evidence that our technological advantages can be compromised. As an example, the *Journal of Electronic Defense* reports that in the 1950s the introduction of the AIM-9 air-to-air missile provided a performance advantage that far exceeded its U.S. designers' expectations. Yet the Soviets were able to acquire the technology inherent in this missile and quickly reverse-engineer it into an AIM-9 clone known by the NATO code name of AA-2 "Atoll" (Taylor, 1999).

## INCORPORATING ANTI-TAMPER

The process for incorporating AT techniques rests upon the firm foundation of the systems engineering discipline. As with all complex engineering tasks, if one is to succeed in developing a solution to satisfy some need, the need itself must be thoroughly understood and properly translated into performance and technical requirements. The means by which we determine what, if any, AT techniques should be incorporated into a weapon system and how is no different. Figure 1 illustrates the process for determining AT requirements.

The process of interest can be divided into two main parts: the front half, which involves developing an estimate of the means and probability of exploitation, and

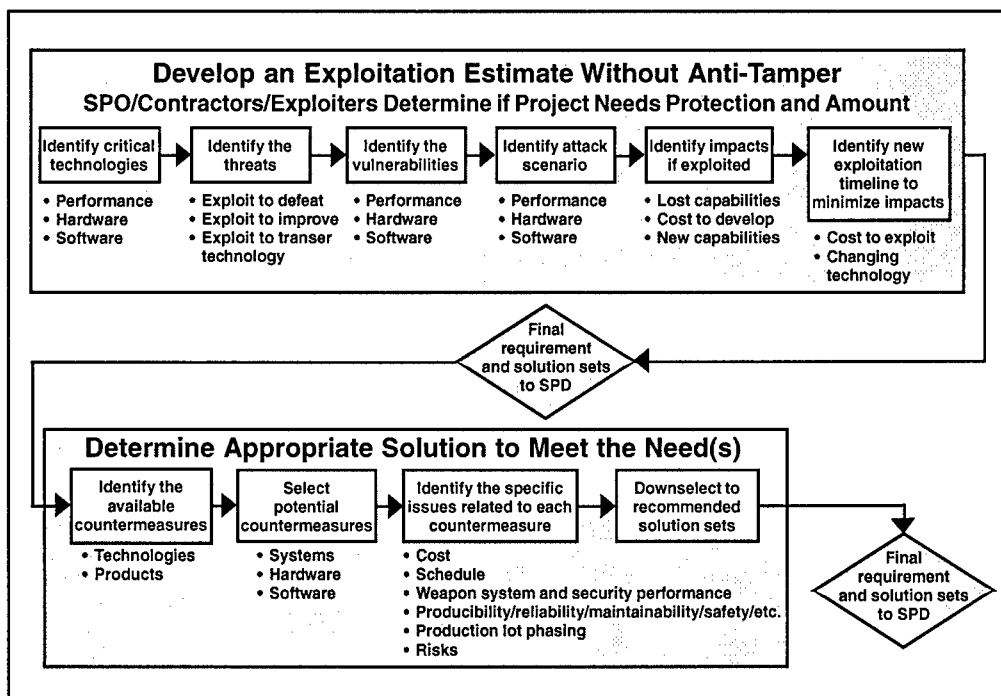


**Figure 1. Determining Anti-Tamper Requirements**

the back half, where one determines an appropriate solution to the need once it has been properly characterized. The first main part is depicted in the top half of Figure 1 and consists of six steps. These first six steps are usually performed by the contractor in cooperation with government engineers.

The first of these steps is to identify the critical technologies that are under consideration for design into a weapon system. What constitutes a "critical technology" was defined earlier. Critical technologies include both software and hardware. Once these technologies have been identified, the "threats" to them are usually ascertained through some process involving "red-teaming" or scrutiny by those experts in friendly and adversarial exploitation. This step consists not only of identifying who might be interested and capable of exploiting identified critical technologies, but why and how they might be exploited. Technologies can be exploited to determine how they can be defeated or how they can be reengineered and improved upon.

According to DoD 5200.1-M, when a program contains critical technologies that may require protection:

...a multidisciplinary counterintelligence threat assessment and a risk assessment are conducted. These assessments provide the basis for any decision pertaining to the protection of the [critical technologies] as part of the overall risk management strategy and the implementation of cost-effective risk mitigation measures (i.e., countermeasures).

It is important to emphasize here that as the DoD manual implicitly recognizes, there exists no need to consider the incorporation of AT techniques absent a critical technology or threat. Only those systems that contain critical technology need go through this process.

The next two steps consist of identifying both vulnerabilities of critical technologies to exploitation and the actual means by which they might be exploited. Again, these assessments must look to the hardware and software aspects of a system and their relationship to system performance. These steps are critical to the design efforts going into the weapon system proper, since they usually indicate if and where measures must be taken to protect the constituent critical technologies. Performing these steps may also provide important insights—for example, that exploitation may be possible but very difficult. This information can be extremely useful for tradeoffs to be conducted later in the process.

While understanding how a critical technology can be exploited is very insightful, so is projecting what the impacts would be if exploitation efforts were indeed successful. For example, if a critical technology is exploited, it may result in countermeasure developments that render the weapon system performance inadequate to do the job. By the same token, exploitation may not result in lost capability if other factors are important to the realization of a weapon system's full performance potential. Another factor that should be considered is the cost to develop replacement technology or to find other means to regain lost military advantage. Such data can be important for determining if the cost of

incorporating protective schemes are worthwhile compared to the cost of measures that must be taken once a technology is compromised.

The last step in the front half of the requirements process is to assess possible exploitation timelines that serve to mitigate the need for, or required amount of, AT necessary for a weapon system. To illustrate, consider the impact of the pace of technological advancement in the microprocessor field. When a certain microprocessor, let us say an application-specific integrated circuit (ASIC), is designed into a weapon system, it may indeed represent a critical technology. But when one considers that similar commercial technology will match and overcome the ASIC's performance capabilities within 3 to 5 years, it may not make much sense to invest heavily in its protection through AT. The technological advantage will be lost in a relatively short amount of time through means available on the open market.

In contrast, consider the case of protection of software through encryption. Use of more sophisticated means for encryption may not render a software code absolutely secure, but it might increase the time it takes to break the encryption code by an order of magnitude—ensuring that the weapon cannot be exploited during its expected life. (A bit more detail on this form of AT will be discussed below.) Again, such information becomes very important in the tradeoff process for choosing and incorporating affordable AT techniques.

Once the first six steps of the process are complete, then a preliminary requirement for AT can be stipulated. Like all requirements in the weapon system

development process, the AT requirement should not be considered absolute, but is something that must be balanced with cost, schedule, and military utility. Anti-tamper is not immune to tradeoffs that must be made as mandated by the policy of cost as an independent variable (CAIV).

The second main part or back half of the requirements process consists of four steps. The first of these is to identify AT techniques that are available to counter the exploitation threats. The nature of the critical technologies requiring protection will naturally provide a first filter for those techniques that may have application. At this stage the alternatives being considered may be quite different even if they have the same end result, that is, to inhibit exploitation. The second step is to select a preliminary set of potential counter-

***"Like all requirements in the weapon system development process, the AT requirement should not be considered absolute..."***

measures that are identified for more in-depth analysis. This first "cut" can usually be accomplished by eliminating those options whose affordability or efficacy are clearly unattractive compared to the other options. Typically a top-level look at the countermeasures proposed will surface relative strengths and weaknesses that facilitate this initial tradeoff.

During the third step a traditional engineering design analysis is conducted in which all considerations are accounted for and evaluated. On the weapon system design side such considerations include life-cycle cost, implications for schedule (both development and production),

impact on weapon system performance, ease of manufacture, reliability and maintainability, and safety. But a proper analysis also accounts for the relative merit of an AT technique for inhibiting exploitation, the anticipated timeline and cost that exploitation efforts will take, and the likely time-frame over which the technologies to be protected will remain critical or

**"The last step in the AT requirements process is final selection of the favored solution set."**

essential. For example, if a program only gains five years of protection from AT for a \$10 million investment and the program is only spending \$50 million on the entire RDT&E process, one may question the wisdom of spending the additional 20 percent for such limited results. However, if that same technique could give another program 10 years of protection for the same cost and if the total program budget is larger, then the relative benefit appears much more attractive.

To systems engineers, this evaluation methodology is nothing new or unfamiliar. It simply incorporates another "performance" requirement that is subject to the same kinds of analyses and tradeoffs that they are used to making. It may make final design choices a bit more complex, but it is no less subject to CAIV considerations as any other decision in the engineering design process.

The last step in the AT requirements process is final selection of the favored solution set. This solution may not be unique; another choice may achieve similar results at a similar cost. The dimension that wins the day may not be

intuitively obvious, and that is why a thorough analysis should not be overlooked. It does little good to protect one avenue of exploitation if another is left open. As the adage goes, putting a special lock or bolt on the outside of the front door will not protect the back gate.

## ANTI-TAMPER TECHNIQUES

For self-evident reasons, a detailed description of AT techniques can not be presented in an unclassified forum. It is U.S. policy to acknowledge that AT techniques are incorporated into the designs of its weapon systems, but to say nothing of their detailed nature. Many techniques are "fragile" in that the very knowledge of their specific application to protect a particular technology will greatly aid the exploitation process. No AT technique is fool-proof, and it defeats the purpose of incorporating it if an adversary is tipped off to what he is dealing with as he attempts to exploit the technology that has fallen into his hands. Since these techniques are not fool-proof, an "onion layered" approach may be necessary. Generally speaking, overlaid techniques provide more robust protection.

Nevertheless, it is possible to list a few generic examples that illustrate the kinds of options available to the program manager. These examples include:

- nonetchable thin opaque coatings applied to semiconductor wafers;
- self-destructing components; and
- cryptography to include encryption and decryption.

Coatings serve to make it very difficult to extract or dissect microelectronic components without greatly damaging them in the process. Self-destructing components may seem akin to the assignment tapes from the Mission Impossible series, yet in their essential respects they really are no different. After use or when exposed to certain environments, devices employing this form of AT damage themselves beyond reconstruction. However, a lesson learned from this technique is that employing it can have important implications for system operation and maintenance. For instance, if a system needs to go to a depot for repairs, it may be difficult to remove a cover or open a lid if an explosive is primed and ready to erupt upon doing so.

We can examine the last example—encryption—in more detail because it is a common technique found in the commercial as well as military world to protect software code and various forms of communication. Encryption can be defined in simple terms as the scrambling of instructions to make them unintelligible without first being reprocessed through some sort

of deciphering technique. Anyone looking at encrypted data sees only cipher text, that is, a bunch of nonsense letters, numerals and symbols. The mathematical formula for accomplishing the deciphering process is an algorithm that takes time to solve. Depending to some degree on the type of algorithm used, the larger the number of bits used in the encryption process, the longer the time it will take to complete the deciphering process. The adjacent table provides some insight into the nature of this relationship (Krey, 1997). Obviously, in this example, the bit length the designer will shoot for will depend on what the technology will support for a given engineering application, the associated cost, the nature of the exploitation threat, and the anticipated time the protected information is expected to remain critical.

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### **LESSONS LEARNED**

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A number of acquisition programs have already embraced AT techniques to make

**Table 1. Code Breaking Times**

| No. of bits | Time                   |
|-------------|------------------------|
| 40          | 2 seconds              |
| 56          | 35 hours               |
| 64          | 1 year                 |
| 80          | 70,000 years           |
| 112         | 10 <sup>14</sup> years |
| 128         | 10 <sup>19</sup> years |

their weapon systems more secure. Such action has facilitated the process to permit sales of these systems to allies and other foreign customers. One of the lessons learned from these programs is that incorporation of AT after the system design has been frozen is extremely expensive. It is not that all AT techniques are in themselves expensive, but their affordability is critically dependent on when they are introduced into the design process. If AT is treated as a performance requirement from the beginning, it is much easier and cost-effective to incorporate as compared to "bolting it on" later.

Another lesson learned is that system engineers should thoroughly explore the

**"Unfortunately, few have arrived at the enlightened position that AT is a viable option to fulfill broadly applicable program protection policies."**

use of existing AT applications before committing to development of a brand new technique. Such "re-use" will often fulfill a requirement and obviate the need to "rein-

vent the wheel." For example, algorithms used for encryption can be modified slightly to provide a completely different type of protection than was originally envisioned.

Still another lesson learned is that many program managers will not address AT concerns unless the need is specified within program management directives or operational requirements documents.

Unfortunately, few have arrived at the enlightened position that AT is a viable option to fulfill broadly applicable program protection policies. The short-term answer to this dilemma is to have the

operational requirements development community specify the need to protect critical technologies inherent in weapon systems from compromise or reverse engineering. Alternately, the program management directives can be used to task program managers to do the same. Unfortunately, these actions may be the only way to ensure adoption of AT techniques until they enjoy more widespread acceptance.

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## POLICY UPDATE

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A big boost for the AT cause came about on February 11, 1999, when Jacques Gansler, Assistant Secretary of Defense for Acquisition and Technology, signed out a memorandum fostering implementation of AT techniques in military acquisition programs (1999):

The Department seeks to preserve the U.S. and [friendly] Foreign Governments' investment in critical technologies through implementation of Anti-Tamper (AT) techniques and practices...Anti-Tamper is based on existing DoD5200.1M program security requirements... Once [a new policy is] approved, AT will be incorporated in new programs and modifications to programs where appropriate.

The memo stipulates that the director for Strategic and Tactical Systems (S&TS) is to assume Office of the Secretary of Defense oversight, coordination, and policy responsibilities for AT within the DoD. The memo further directs that S&TS

convene an integrated product team to prepare a DoD AT policy. Additionally, Service, U.S. Special Operations Command, Ballistic Missile Defense Organization, and Agency acquisition executives are to assess all acquisition category weapon system programs to determine the extent of AT implementation and to report on their observations.

In parallel, efforts are under way to revise DoD 5000.1-M to explicitly state that program managers will assess AT for incorporation into their weapon system acquisitions as part of the program security process. Once accomplished, program managers may elect not to incorporate AT techniques into their weapons developments, but the onus will be on them to demonstrate why and how they intend to address the exploitation threat.

## **SUMMARY**

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From the foregoing discussion it should be clear that the incorporation of AT techniques provides significant benefits.

- Anti-tamper prevents or mitigates the unauthorized or inadvertent disclosure of U.S. technology as well as its exploitation.
- Anti-tamper protects the U.S. warfighter from countermeasures development.
- Anti-tamper enables foreign military sales to be consummated with greater confidence that U.S. technologies will not be compromised.

- Anti-tamper reduces the burden on the taxpayer by helping to sustain U.S. technological advantages.

At the beginning of this article we postulated a speculative future scenario in which advanced military technology was lost into enemy hands with the distinct probability that it would soon be compromised. Perhaps some will find such a scenario difficult to accept as possible or likely. For those who continue to resist the imperative for assessing what role, if any, AT techniques should play in their program, we offer up this historical vignette.

***"From the foregoing discussion it should be clear that the incorporation of AT techniques provides significant benefits."***

In 1915 during World War I, Anthony Fokker, the great Dutch aviation pioneer, revolutionized aerial combat when he developed a synchronizing system to permit a forward-firing machine gun to shoot through an airplane's nose-mounted whirling propeller blades. Prior to Fokker's invention, airmen wishing to engage enemy aircraft were forced to armor their wooden propellers with steel liners and risk hitting them or fire their guns over the top or to the side of the aircraft, which was much less accurate. With Fokker's mechanism, German aircraft gained the advantage over the Allies and established air superiority.

But the advantage was short-lived, because soon thereafter a German pilot was captured with his aircraft behind French lines when he became lost in bad weather. The Allies quickly copied the Fokker mechanism and even improved

upon it by devising a hydraulic synchronizer that interrupted the gun's firing pattern so bullets were prevented from being fired when a blade passed through the line of fire. With equivalent capability in hand, the Allies quickly reestablished parity in the air (Hildreth and Nalty, 1969).

The reality of exploitation is inescapable. It is supported by historical prece-

dent and current threat assessments. Anti-tamper technology is an affordable means to provide life-cycle program protection to essential or critical U.S. military technologies. Recently established DoD policy mandates that program managers assess whether AT techniques are appropriate for their acquisition programs, be they new or upgrades. The time to act is now.



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# PAVING THE WAY FOR PRICE-BASED ACQUISITION

***Edward L. Will***

One of the leading visions of the Defense Reform Initiative is "igniting a revolution in business affairs within the Department of Defense (DoD) that will bring to the Department management techniques and business practices that have restored American corporations to leadership in the marketplace" (Cohen, February 1998). The current study of price-based acquisition (PBA), first recommended by Secretary of Defense William Cohen in his Section 912 report (April 1998), is an important step in this direction, and is important to another DoD goal: civil-military integration. Acquisition reform initiatives over the past several years have already paved the way for changing to PBA. Waivers of cost and pricing data and other price analysis methods have demonstrated that DoD can rely on these approaches to obtain best value for the war-fighter as well as the taxpayer. PBA can be a logical extension to these trends and build on our successes to date in reducing acquisition cost and cycle time.

**F**or several decades, the DoD has relied increasingly on cost-based proposals for its contracting process. This emphasis on cost-based information has led to the imposition of unique accounting systems, extensive auditing, growing cycle times, and a loss of focus on best value. As noted by the Defense Science Board (1993):

The pace of change and proliferation of technology is increasingly driven by commercial markets. Commercial industry is increas-

ingly the dominant factor in several modern technologies and products that are militarily important. The focus and intensity of investment in new industrial techniques in manufacturing, process development, and product design in most commercial industries is far ahead of dedicated defense system producers.

DoD has grown increasingly concerned that its unique contracting requirements prevented it from tapping these commercial

sources. The Section 912 report (Cohen, April 1998) pointed the way to a new approach:

In the past, the Department [of Defense], because of the nature of the marketplace and the fact that in many cases the goods and services the Department purchased were unique, found it necessary to purchase the goods and services it acquired using cost-based contracts built on the actual or projected cost of an item or service. Both the nature of the department's requirements and the way in which prices can be determined have changed. Now, DoD is promoting the use of performance-based requirements that talk of needs in terms of capability required. In many cases this will permit the department's needs to be satisfied with commercial products. Where commercial products aren't available, DoD's needs can often be satisfied through the use of commercial practices and/or commercial facilities in the provision of services or the production of goods (e.g., producing defense-unique items on commercial production lines using flexible tooling).

Over the past year, DoD has undertaken one of the most important initiatives of the "revolution in business affairs"—the study of price-based acquisition.

The Section 800 Commission report (1993) identified a reliance on cost-based accounting as one of its primary concerns.

Likewise, the Coopers & Lybrand/TASC study (1994) identified the cost accounting standards (CAS), material management accounting system (MMAS), and the Truth in Negotiations Act (TINA) as three of the top 10 areas where the DoD paid a premium over comparable civil systems. With regard to TINA, the report stated:

To comply with these requirements, contractors must establish and maintain an elaborate system for estimating, segregating, and tracking costs. The TINA requirement to provide certified cost and pricing data, and especially the large amount of auditing and other government oversight associated with this requirement, is a unique feature of the defense market. All of the contractors visited by the project team acknowledge that there will always be a need in many cases for some cost-based mechanism to validate prices in the defense market. There was also wide agreement that DoD should reduce its requirements for detailed cost data by easing restrictions on the use of price analysis and taking greater advantage of historical price information.

The Federal Acquisition Streamlining Act (FASA) of 1994 and the Clinger-Cohen Act of 1996 began to lay the foundation for change. The Federal Acquisition Regulation (FAR) Part 12 is an example, permitting the U.S. government to buy commercial items as any other buyer of goods and services. The rewrite of FAR Part 15 (1997) introduced still

further improvements, such as clearly making the request for certified cost and pricing data last in priority for contracting officers, after all other price-based methods were deemed inappropriate.

The follow-up study done by Coopers & Lybrand (1997) on the awareness and state of implementation confirmed that some progress was being made with TINA as one of the top 10 premium cost drivers, but there was no progress in the areas of CAS and MMAS. The report concluded by saying "continued commitment to training is vital. Special emphasis is needed in market research/exemptions to certified cost and pricing data, parametric estimating, commercial product definition and pricing..." (Coopers & Lybrand, 1997).

There is very little that is truly new here—for the concept of resorting to cost and pricing data last was always embraced in concept by the FAR. In practice, however, contracting officers were wary of failing to ask for extensive cost and pricing data either in competitions or in sole-source procurements, even if extensive prior price history was available. Their judgment could be called into question by any of the numerous oversight functions if they failed to demonstrate their rationale for arriving at a "fair and reasonable" price. Furthermore, competition is not always feasible nor is it completely accepted as the only best business practice—long-term partnering is also viewed as a way customers and suppliers can work together effectively for mutual benefit.

In response to Congressional desire to reduce the size of the defense acquisition workforce, the Defense Science Board recommended further steps to enhance price-based acquisition (1998): "Increase

the use of price-based forms of contracting. Several contract vehicles exist that do not carry the onerous overhead burden of cost-based contracts, and their use must become the rule rather than the exception. The greatest management challenges that must be overcome are to develop feasible price-based contracting options that are both performance-based and competitive, and to educate the acquisition workforce in these alternatives to cost-based contracts."

**"Special emphasis is needed in market research/exemptions to certified cost and pricing data, parametric estimating, commercial product definition and pricing..."**

As DoD's second largest contractor and also the largest commercial aerospace company in the world, the Boeing Company has long advocated using best commercial practices in government contracting. It has been a participant in both Coopers & Lybrand studies and has worked with DoD to demonstrate how price-based acquisition can become the norm. And the Boeing Company is completely committed to the principles of civil-military integration.

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## **THE FIRST PARADIGM SHIFT**

The first paradigm change that began to lead DoD contracting officers and their contractors away from the cost-based proposal paradigm was, oddly enough, a process to apply the principles of integrated product teams (IPTs) to the creation and negotiation of cost proposals. It is most often used in sole-source

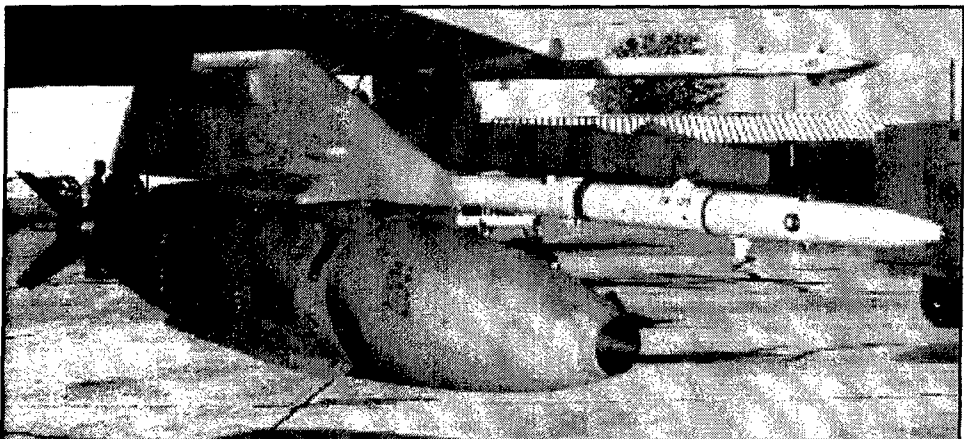


**The most successful of the FASA-authorized pilot programs—the joint direct attack munition (JDAM).**

procurements, but has been applied even in competitive situations such as “rolling down-selects” pioneered by the most successful of the FASA-authorized pilot programs—the joint direct attack munition (JDAM). This new teaming process has been called “alpha contracting,” “IPT pricing,” or “one-pass contracting.”

Whatever its name, it brings all the parties together as the requirements are defined and the cost proposal developed.

This can be approached as a single multidisciplinary team or operate within the program’s existing IPT structure. The team from the program office is headed by the contracting officer, and is joined by the local Defense Contract Management Command (DCMC) and Defense Contract Audit Agency (DCAA) personnel. They work together with the contractor’s technical, contracts, and cost estimating staff to develop the estimate. Very often this leads



cost drivers are understood. This is a simple but effective form of cost as an independent variable (CAIV).

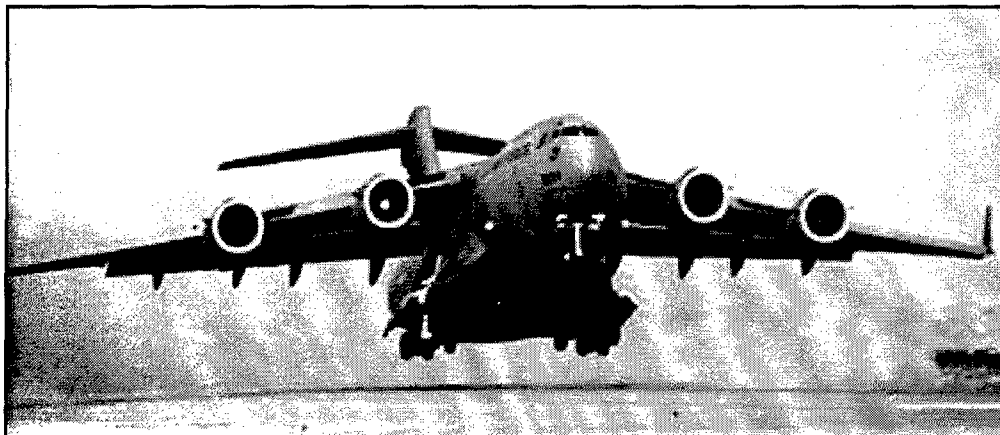
Rather than "throwing the proposal over the wall" to the government program office for evaluation, this team approach traces requirements to schedule and costs, identifies the appropriate bases for estimates, and agrees on historical data most appropriate to use and supporting rationale. Thus, proposal preparation and fact-finding are combined into a seamless process, with a significant reduction in cycle time and greater confidence in the resulting contract scope and estimated value.

Our experience across a wide spectrum of customers with all the DoD Services has taught us that there is a learning curve to this process. The first experience requires patience, team building, and adherence to an agreed schedule. Travel costs and meeting time will appear excessive at first. More advanced IPTs have actually included review of key suppliers' proposals and supporting information. DCAA can and should participate, but rightfully needs to maintain its ability to review the results objectively, while contributing with advice throughout the process.

The results are dramatic. Acquisition cycle time is reduced. New relationships are established based on trust and respect. The underlying data is better understood. Negotiations are likely to be measured in minutes or hours rather than days or weeks, with less disagreement over fundamental issues since requirements and the scope have been shaped to be affordable.

Out of this process can come new tools that advance acquisition methods still further, such as:

- Advance agreements on cost estimating relationships (CERs), one of the first steps toward using parametric estimating to replace "bottoms up" estimating.
- Establishment of long-term indefinite delivery-indefinite quality (IDIQ) or other such contracts for a variety of items for customer product support. This is the beginning of a "catalog" approach tailored to military procurement.
- Development of cost models that have the agreement of all the parties and can be used to simulate, if not actually fully price, follow-on contracts. One of the leading examples of this is the C-17 *Globemaster III* program where an extensive cost model was used to establish the basis for the "should-cost" and subsequent multiyear contract. This model has buy-in from all the parties and continues to be used today.
- Sharing and exchange of data electronically—the onset of "paperless contracting"—to reduce travel and meeting time for all the participants. The most recent example of this has been on the fiscal year 1999 production contract for the Standoff Land Attack Missile Expanded Response (SLAM ER) program. Both the program office's requirements and contract documentation as well as the contractor's cost and supporting information are located on a shared server to allow secure access by all parties. This is viewed as the beginning of administering the contract throughout its performance and to closeout in electronic form.



**The C-17 Globemaster III**

### **THE SECOND PARADIGM SHIFT**

Within the past few years, the heads of contracting activities (HCAs) (U.S. Code, YEAR) have been granted authority to waive cost and pricing data if it was clear that other price-based analyses could be used, such as reliance on adequate price history. These same HCAs have been

under increasing pressure to reduce acquisition staffs and cycle time. Support groups such as the DCMC and the DCAA have likewise been under pressure to reduce staff, potentially increasing the burden on them and resulting in delays for contracting officers when assist audits for cost proposals are requested.



The JDAM final proposal was only in the tens of pages rather than the thousands on other similar programs in the past—even though the contract for the second phase of engineering and manufacturing development (E&MD) was to be cost reimbursable. It also contained fixed-price options for the first two low-rate production lots and price commitments for the following three full-rate production lots. This was made possible due both to competition and to having the customer engaged in the contractor's design to cost efforts throughout the first E&MD phase.

However, sole-source contracts are still the contract actions that commit the largest share of DoD procurement funding each year. Due to the confidence gained through the use of alpha contracting experiences described above as well as extensive price history, contracting officers began to request waivers of certified cost and pricing data on major sole-source programs from HCAs within the past three years.

One of the first experiences at the Boeing company was on a production fighter and attack aircraft program with a 15-year history. The production lot included quantities for both the Service and a foreign military sale. The program office challenged the company to meet a price objective—with the promise to obtain a waiver of cost and pricing data if we did. We provided our price offer and some supporting data (involving larger subcontractors) within 30 days. The Service agreed with the price and obtained the waiver for this billion-dollar procurement (U.S. Navy memorandum, 1996). The contracting officer for this contract said that "procurement administrative lead time was reduced by six to eight months

through waiver of cost/pricing data while securing a favorable price" (Rosendorf, 1996). Shortly thereafter, this success was repeated on another fiscal year annual production buy of more than \$100 million by another Service for a foreign military sale of rotor craft (U.S. Army memorandum, 1996).

In both instances, price agreement preceded granting of the waiver by the HCA. However, with another Service for a more complicated purchase (one year of production aircraft and two option years), the waiver was obtained in advance of price submittal and negotiation (U.S. Air Force memorandum, 1996). In all these instances, the Boeing Company as the prime contractor requested waiver not only for ourselves, but also for our subcontractors, and usually these were granted. However, in many cases we

had already begun the process of obtaining supplier quotes with cost and pricing data due to the lead times to support our cost proposal. This demonstrates one of the lessons learned in the waiver process—for maximum savings, flowing down to suppliers, the waiver should be granted well in advance of normal proposal submission.

After several more of these waivers were granted on large production programs, the resident DCAA auditor prepared an article for an in-house newsletter in which he listed the benefits of such waivers (Bailey, 1996):

**"However, sole-source contracts are still the contract actions that commit the largest share of DoD procurement funding each year."**

- Cycle times for definitization of contracts that previously had taken between 6 and 24 months could be reduced to a 30- to 60-day period.
- Favorable pricing could be obtained in consideration for eliminating the government's right to seek adjustments due to inaccurate disclosure.
- The contractor must accept more risk because of less actual cost incurred before the contract is awarded.
- Data submissions are more manageable.
- Funds can be committed more quickly and when available.
- The waivers eliminate the need for long lead contracts.
- There is less oversight for all parties.

Progress has continued as our customers have increased their confidence in this tool for acquisition streamlining. A waiver of cost and pricing data was given for the recurring production rotor craft portion of a multiyear prime contract totaling about a billion dollars. The initial price proposal was only about 10 pages, although some additional information was supplied in several meetings to support the contracting officer's determination of a "fair and reasonable" price. Certified cost and pricing data was still required for some of the major subcontractors. The entire process, from request for proposal through definitization, took only six months.

In one particularly innovative approach, a tactical missile program that had long been in production, developed a series of

price curves reflecting various quantities and configurations to be ordered during the fiscal year. This was commonplace on this program, due to foreign military sale orders, but had never before been settled on a price basis, which greatly simplified the process. A request for proposal was originally issued anticipating full cost and pricing data, but within the next 90 days, discussions commenced on using a price-based methodology. After an exchange of information over a period of slightly more than two months, negotiations were concluded in a week-long meeting. The program was then granted a waiver of cost and pricing data.

As with alpha contracting, there is a learning process associated with this methodology also. All parties must have confidence that dealings are on a fair and equitable basis. Price history must be well established, although we have found that quantities can rise or fall and adjustments still be made without resorting to cost data. The low level of inflation throughout this process has undoubtedly helped, but this need not be prohibitive since economic price adjustment or adjustment of abnormal inflation in economy clauses have often been used in both military and commercial aircraft procurements.

The savings in cost and cycle time for these waivers are significant. During a three- to four-year period, one of Boeing's major sites with several large production programs and its customers were able to realize a reduction of 50 percent in proposal and contract cycle time. As an example, one annual production buy of 12 aircraft well in excess of \$100 million was accomplished in just over two months with a fully definitized contract in place on the first day of the fiscal year.

## **THE CHANGES CONTINUE**

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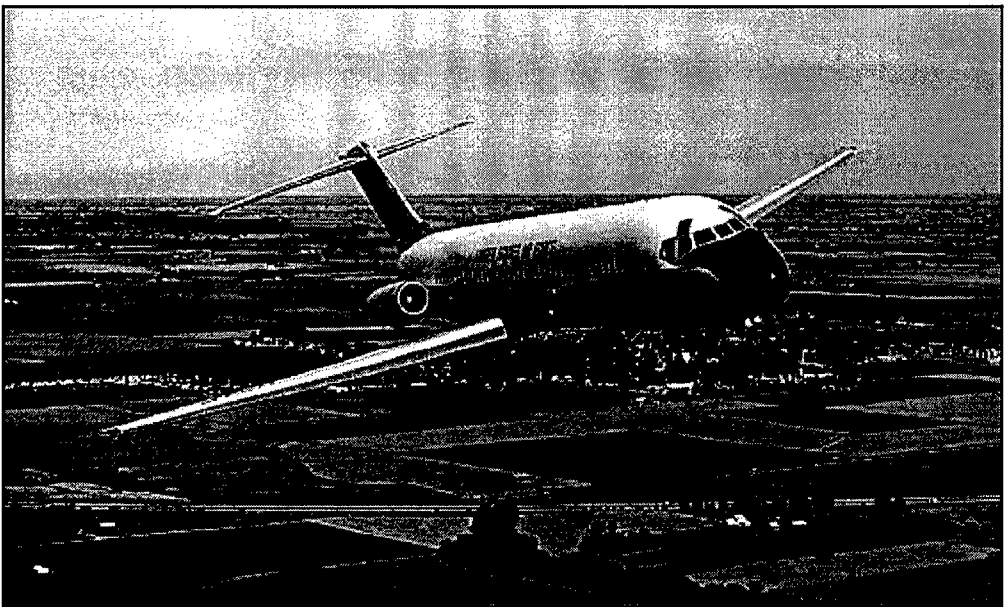
FAR Part 12 is the new instrument to enable the DoD to procure commercial items more easily than before, using contracting terms and conditions customary to that business area. It "prescribes policies and procedures unique to the acquisition of commercial items. It implements the federal government's preference for the acquisition of commercial items contained in Title VIII of the Federal Acquisition Streamlining Act of 1994 by establishing acquisition policies more closely resembling those of the commercial marketplace and encouraging the acquisition of commercial items and components." It also provides a comprehensive definition of the term "commercial" which broadens its use to a variety of products and services.

It is not unusual for DoD to procure commercial transport aircraft for a variety of military missions. As Billy Mitchell

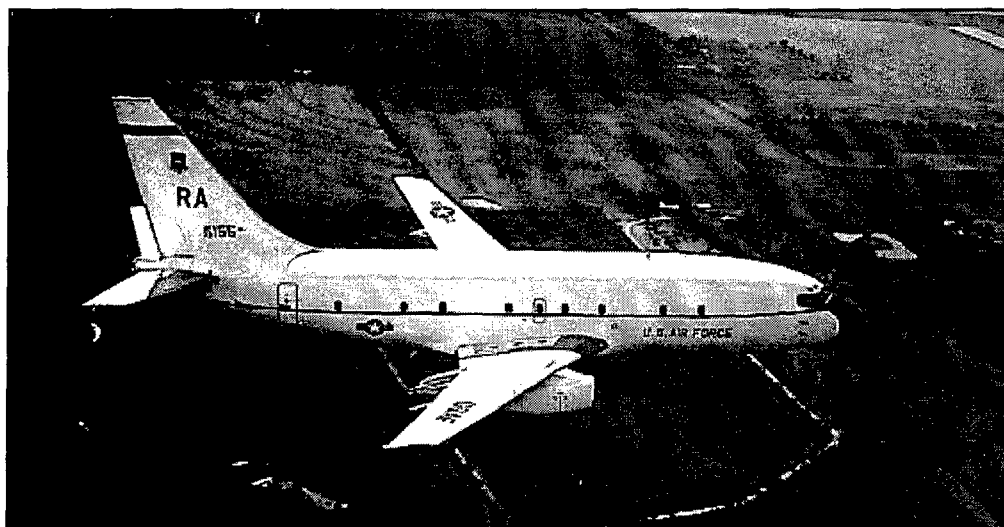
once noted (1921): "In the development of national aeronautics, commercial aviation is almost as great an asset as if it were regularly incorporated into fighting units."

Examples of this ongoing civil-military integration abound during and since World War II. They include:

- C-47 and RAF *Dakota*;
- C-135 and KC-135 cargo/tanker;
- E-3A and E-4A AWACS and national command post;
- T-43A navigational trainer;
- KC-10 Air Force tanker;
- C-9 for Navy and Air Force; and
- C-32 and C-40.



**C-9**



**T-43A Navigational Trainer**

The C-32 for the U.S. Air Force and the C-40 for the U.S. Navy are some of the most recent examples of DoD procurements today under FAR Part 12. In both cases, commercial pricing was obtained, including for many of the modifications deemed to be of a type customary for the marketplace or minor modifications for unique defense needs. One of these, the C-32, received the Hammer Award for Reinventing Government from Vice President Al Gore.

In still another arena, contractors and their DoD customers have been exploring various approaches to streamlining the spares acquisition process. One attractive alternative is to establish a catalog for DoD ordering, which can be accessed electronically. It can supply price as well as schedule, lead time, and delivery information.

The Boeing Company has given all DoD customers the opportunity to use the Boeing Partner Network to acquire spares for commercial aircraft. A similar catalog

ordering for military aircraft and rotor craft has been developed recently. In this case, the local administrative contracting officer negotiates prices, if necessary, and the Boeing Company agrees to hold these prices for a year, with an agreed quantity discount provision, in its catalog. In one case, we have a Service customer using IMPACT purchase cards to acquire such spares.

Although contract formation can be accomplished on a price basis, some have worried that the cost basis must be maintained for payments. Obviously, with the enactment of performance-based milestone payments, this need is eliminated. Boeing has performance-based milestone payments in place on two large multiyear procurement programs that are working very well. For commercial items, the U.S. government can elect to use payments customary to that business sector, including advance payments of up to 10 percent of the price.

## **CONCLUSIONS**

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The specifics of DoD's new price-based acquisition policies have not been published (as this article went to press). It is clear, however, that a pathway has been created that will allow contracting officers to embrace this change. Progress in alpha contracting, waivers of certified cost and pricing data, purchase of commercial items, and using catalogs for small purchases are demonstrating the value of PBA. The savings in acquisition cycle time and cost can be significant.

Whatever the PBA policies are, they should be added to the new acquisition "tool box" for contracting officers to be used as the situation demands. If we should have learned any one thing from acquisition reform, it is that there is no single best solution—for judging past performance, for using performance or detail specifications, for any single product sustainment approach, or for contracting. Contracting demands the flexibility to balance risk, requirements, schedules, and costs for both parties. PBA will provide still another tool set that can help contracting officers acquire commercially available technology and also help bridge the civil-military integration gap.

It is hoped that PBA does build on these experiences, and that:

- It will be used to encourage teamwork in developing the contract, specifications, statements of objectives or work, use of CAIV, application of parametric estimating methods, and cost modeling by all the parties involved in the acquisition process.
- Use will be made of commercial item exemptions, expanded to include commercial sites. If the vast majority of the work at a site is commercial, then CAS should not be imposed for a small amount of military work. This would negate the imposition of TINA for certified cost and pricing data. Instead, contracting officers will rely on freely supplied information regarding cost drivers from accounting systems that comply with generally accepted accounting principles to support CAIV tradeoffs and to determine "price reasonableness."
- Greater use should be made of waivers of cost and pricing data. We have already proven that other price analysis tools can suffice, such as market analysis, cost models and parametric estimating techniques, or adequate price history. A truly dramatic paradigm shift, similar to that undertaken by then-Secretary of Defense William Perry for military specifications and standards (1994), would be to require a waiver for a contracting officer to request certified cost and pricing data. This would ensure that contracting officers had exhausted all alternatives to PBA before resorting to cost-based approaches.
- It should encourage use of these tools at all levels of the supply chain. Often DoD's policies fail to penetrate through the layers of the supply chain from the prime contractors. These suppliers can easily represent more than half the cost of any system. To some degree, this is the responsibility of the prime contractor but DoD must also encourage the

whole supply chain. FAR Part 12 does this with a flow-down provision that permits use of commercial item exemptions anywhere in the supply chain. Similarly, DoD should consider policies that essentially grant HCA authority to primes at any level to waive supplier cost and pricing data. Such waivers must still meet the test of reasonableness that a contracting officer must meet. The prime should demonstrate that market pricing, cost modeling, or adequate price history are available and sufficient to arrive at a negotiation objective. DoD remains at the top of this "pyramid" and can ultimately render a judgment on the price determination reflected in the price or cost proposal presented for negotiation. Some of the greatest gains in cost and cycle time will accrue at these subcontract levels.

- It should encourage training, more training, and a tolerance for risk taking. We have seen great progress in

acquisition reform, but a common complaint is the lack of training in these new concepts and tools. This has been noted in revolution in business affairs goals, and progress has already been made. For example, Stan Soloway's DoD acquisition reform office has held a number of excellent nationwide video broadcasts. But many of the tools discussed in this paper are still the exceptions and are not commonplace, which demonstrates the need to continue training. It also demonstrates the need for top-level management support of these tools. DoD awards should be given to those teams that best support their war-fighter customers and DoD's policies by reducing acquisition cost and lead times. PBA will require still further training to be successful. There is an advantage, we have learned, to conducting training of industry and government at the same time, as both need to shed their old cultural roots and step out on this pathway to the future.



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# SPS AND BEYOND: INNOVATING ACQUISITION THROUGH INTELLIGENT ELECTRONIC CONTRACTING

*Dr. Mark E. Nissen*

The Standard procurement System (SPS) uses information technologies (IT) to support defense procurement through workflow technology. Although SPS has overcome many of the severe pathologies associated with the Defense procurement process, it is only a humble beginning for the application of state of the art in electronic contracting. This article outlines key aspects and limitations of next-generation information technology including waivers of cost and pricing data and other price analysis methods. SPS officials are challenged to investigate and incorporate these powerful technologies into future electronic contracting systems to improve procurement process performance.

**S**ociety is amidst the "third wave" (Toffler, 1980), the information age in which knowledge capital is becoming more important than traditional economic inputs of labor and finance (*Forbes ASAP*, 1997). The nature of work is changing dramatically, and the structure of modern organizations must shift even further to accommodate this quantum change. New organizations are beginning to resemble symphony orchestras more than military commands (Drucker, 1988), and information technology (IT) has become central to process performance

and competitiveness in the enterprise (Davenport and Short, 1990).

## **CONTRACTING IN THE DIGITAL AGE**

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Indeed, most enterprises—including corporations, government agencies, military commands and others—are actively involved with IT-focused process redesign (Bashein et al., 1994). This comes under the rubric of business process reengineering (Hammer and Champy, 1993), process innovation (Davenport,

1993), process improvement (Harrington, 1991) and other monikers for post-total quality management efforts effecting "radical" change and seeking "dramatic" performance improvement (Hammer, 1990). Such radical change and dramatic improvement have effected a fundamental restructuring of the global economy, enabled many enterprises to downsize by 50 percent or more while becoming more flexible and responsive, and sent the market capitalization of knowledge and technology organizations (e.g., Microsoft, Intel, Cisco) to record heights.

The restructured global economy is more demanding—and less forgiving—now than it was even a decade ago when the reengineering phenomenon began. Technology is advancing exponentially, product cycles are shortening logarithmically, global hypercompetition (D'Aveni, 1994) is intensifying, virtual organizations (Davidow and Malone, 1992) are forming along with electronic markets (Malone et al., 1987), and product supply chains are growing increasingly dynamic, critical, and unstable. For example, it is not uncommon to observe groups of firms engaging in strategic partnerships, joint ventures, and integrated supply chains on some products and services, yet competing aggressively and litigating contested intellectual-property rights with the same "partners" in other markets. And most enterprises are simultaneously reducing their supplier bases while searching ever deeper for new product, service, and information innovations and providers.

Further, the speed at which dynamic topologies of supply webs (i.e., networks of individual supply chains) change now outpaces human managerial capabilities. And managing the enterprise supply chain

has never been more difficult, or more important. Indeed, many progressive firms now view procurement as a strategic enterprise process (Gebauer et al., 1998). For instance, many procurement executives are now charged with identifying and developing strategic alliances and joint partnerships, orchestrating vendor-managed inventories, just-in-time delivery of mass-customized products (Pine et al., 1993), participative design, and concurrent engineering across organizational boundaries, and maintaining trust-based relationships—as opposed to executing arms-length transactions—with customers and vendors along the supply chain. As a result, such leading executives require new business skills and need to operate with greater knowledge and speed than ever before.

Procurement and contracting are central to supply-chain management and they have become classic exemplars of knowledge work. Although IT is used to support and streamline many clerical and administrative tasks along the supply chain, the key intellectual activities of such knowledge workers have been stubbornly resistant to process redesign and innovation (Davenport, 1995). In fact, recent case studies of "high-performance" procurement organizations (e.g., see Nissen, 1997) continue to reveal an unimaginable reliance on manual, paper-based, labor-intensive processes that have changed surprisingly little in the half century of IT-based procurement support.

For example, a computer sits on nearly every desk in most procurement organizations, but the critical knowledge work of procurement is not computer-based (Nissen, 1996). Workflow automation (White and Fischer, 1994) and electronic data interchange (Sokol, 1996) enable

digital communication between workers, departments, and organizations, but the procurement work itself still centers on paper documents and forms (granted, now transmitted and printed by computer). IT collaboration tools are becoming available in the marketplace (see Rayport and Sviokla, 1994), but supply-chain managers still overwhelmingly rely on the telephone to coordinate most procurement activities (Gebauer et al., 1998). Some intelligent information-finding agents are being implemented to identify potential trading partners and supply sources, but these simple agents possess only weak domain knowledge and are incapable of enacting the necessary managerial steps required for supply-chain performance. Rather, most key knowledge-work activities are performed by procurement people, not computers, in the traditional, slow, inflexible, unreliable manner no longer appropriate for the dynamics, complexity, and criticality of supply-chain management today.

The objective of this article is to outline key aspects and limitations of the next generations of IT for electronic contracting—focusing in particular on knowledge systems and intelligent agents—against the backdrop of current technology: the standard procurement system (SPS). First is a brief overview of SPS emergence, which summarizes key findings of a recent academic study investigating advanced procurement processes in the Department of Defense (DoD). Based on this study, the paper then continues with discussion of electronic contracting beyond SPS, as systems for powerful procurement-process innovation are identified and described. The paper subsequently closes with important conclusions from the study.

## **STANDARD PROCUREMENT SYSTEM EMERGENCE**

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Standard procurement system is the name for a new application of IT to the domain of military procurement and contracting. Providing integrated support for many activities on the buyer side of (DoD) supply chains, it is essentially workflow technology (see White and Fischer, 1994) adapted for military procurement and contracting. Designed to interface with legacy systems as well as current technology such as electronic data interchange (EDI), electronic commerce bulletin boards, and on-line regulations (e.g., the *Defense Acquisition Deskbook*), SPS moves the DoD forward into the next century.

Interestingly, early SPS requirements and potential for process improvement were revealed in an applied academic study of the Navy procurement process (Nissen, 1996). This intensive, multiple-case study centered on process analysis and re-design and investigated the key procurement and contracting processes involved with a large,

**"Standard procurement system is the name for a new application of IT to the domain of military procurement and contracting."**

multisite command on the West Coast. This particular command was originally selected because it represented an exemplar of innovation in procurement and contracting (e.g., as a Hammer Award recipient), and working through a reinvention laboratory, management was favorably inclined to push barriers to effective contracting through IT. Nonetheless, the study identified a number of serious

process pathologies—including manual, paper-based, labor-intensive, regulation-laden processes with narrow tasks conducted serially by specialists handing off work from one bureaucratic department to another—and recommended an aggressive set of IT-based redesign transformations. The highest-potential redesign alternatives were then simulated to assess the likelihood of performance improvement.

One of these redesign transformations involves the use of workflow technology to support what was a completely manual, paper-based procurement process at the

**"Nonetheless, the SPS represents a significant step forward in contracting technology...."**

time. The simulated performance of this workflow-enabled redesign is impressive, with dramatic procurement administrative

lead-time (PALT) reductions for some processes. For example, simulated performance of the justification and approval (J&A) process suggests a two-thirds reduction in cycle time as likely. Other processes such as RFP preparation have more moderate gains (Nissen, 1997). Based in part on results from this study—and in conjunction with other efforts through the reinvention lab—the contracting organization decided to move into workflow technology and engaged a commercial software provider to adapt an implemented system to support military procurement.

Early experience with the operation and analysis of this procurement workflow system, called "Procurement Desktop" at the time, served as a motivational

exemplar for efficient IT-enabled procurement and provided the impetus for DoD-wide development of the system now known as SPS. Indeed, the developer of Procurement Desktop won the SPS contract award for a design with comparable capability and is busily installing systems and training DoD contracting professionals at the time of this writing.

Early operational results from organizations now using SPS are beginning to confirm academic findings with respect to cycle time made in the study noted above, but a number of SPS-driven problems are emerging simultaneously. These include, for example, lack of SPS systems integration, incomplete SPS functionality, inadequate training and computer-hardware budgets, and resistance to change in contracting organizations (see McCarthy, 1998). Nonetheless, the SPS represents a significant step forward in contracting technology, and its implementation promotes development of the kind of IT infrastructure required to support the more advanced and powerful electronic contracting technologies; that is, it paves the way for electronic contracting beyond SPS.

## **ELECTRONIC CONTRACTING BEYOND SPS**

Clearly, the workflow technology underlying the current generation of SPS represents only a humble beginning to advancing the state of the art in electronic contracting. For example, other findings from the academic study above identify much greater potential for dramatic improvement in process performance, as well as critical limitations to current SPS technology. Three of these findings are highlighted here.

### **NEGLECTIBLE COST IMPROVEMENT THROUGH SPS**

SPS implementation is unlikely to reduce procurement-process cost significantly. This first finding surprises many people in the contracting organization. In stark contrast with the impressive reductions in cycle time mentioned above, simulated activity-based cost for processes redesigned through workflow technology such as SPS shows negligible improvement over the manual, paper-based, labor-intensive process baselines. "The simulation models must be wrong," was the initial reaction from process managers and participants. But the simulation models are carefully constructed and validated before use, and no one questions their results, pointing to dramatic cycle-time reductions. Indeed, the simulations reveal a critical limitation of workflow technology when it is simply overlaid on top of an existing process.

In fact, closer analysis reveals the process steps themselves are fundamentally unchanged by the workflow system. The same people from the same departments are performing the same process tasks, in the same serial sequences, handing off essentially the same work from one to the other as before. Only the interface to these process tasks (i.e., electronic vs. paper-based) has changed. Of course the intermediate work products are communicated more quickly through the technology, but this represents the cycle-time effect discussed above. The same "broken" process can simply operate faster in a broken state through such technology. Indeed, when other IT-based costs such as personnel training, computer-hardware upgrades, network administration, and software maintenance are considered, activity-

based cost can actually increase through workflow technology such as SPS!

This result comes as no surprise to the investigators, for without fundamental change to the underlying work process itself, simply inserting IT such as SPS is colorfully described as "paving the cowpaths" and "automating the mess" (Hammer, 1990). Through the current generation of SPS and prevalent design of procurement processes in the DoD, this colorful description depicts the current state of the art in military contracting today.

### **KNOWLEDGE SYSTEMS COST IMPROVEMENT**

The academic investigation also includes a redesign transformation to advance the state of the art in military contracting. Specifically, a major opportunity for process innovation is identified through what is

expected to power the next generation of SPS: knowledge systems. Knowledge systems involve the

application of artificial intelligence (AI) to assist with some key knowledge-work activities performed by procurement and contracting personnel. The procurement domain is actually well suited to AI-enabled innovation, as processes are clearly delineated and procedural information is often thoroughly documented (e.g., through the Federal Acquisition Regulation [FAR]). The idea is to capture, formalize, and embed procurement and contracting knowledge into the workflow system. Thus, not only does this next-generation IT support procurement workflows

**"SPS implementation is unlikely to reduce procurement-process cost significantly."**

(e.g., like SPS) through electronic infrastructure, but it also provides intelligent assistance to procurement and contracting professionals, in much the same way that more experienced and expert contracting personnel are responsible for assisting junior and less-experienced personnel today.

As examples, an intelligent contracting module can be used to assist a contract

**"Of course, AI technology is not magic, nor does one expect (or desire) to completely replace PCOs."**

specialist with identifying and adhering to the proper procedures to follow in a given procurement. By interpreting user requirements and ac-

cessing the FAR and other applicable regulations (e.g., the DoD FAR Supplement [DFARS], Navy Acquisition Procurement Supplement (NAPS), such an intelligent module can guide the contract specialist through the steps of the procurement, ensure he or she conforms to regulation and statute, and increase the effective experience and skill level of this knowledge worker. Such a module can relieve some of the current oversight and management burden on the responsible procurement contracting officer (PCO) and actually improve process quality as well as cost. Indeed, simulated process performance corresponding to this AI-based redesign differs from its workflow-only counterpart above by reducing cost and cycle time for the process (See Nissen, 1997 for details).

Another example of AI-based contracting assistance supports the PCO directly. Consider, for instance, the many reviews performed by PCOs today (e.g., of J&As,

draft RFPs, determinations, and findings). With knowledge systems technology appropriately developed to assist the contract specialist and ensure compliance with regulation, policy, and prudence, many of the perfunctory reviews may not need to be performed at all. Moreover, complementary PCO-oriented technology can even be applied to perform these reviews automatically. Of course, AI technology is not magic, nor does one expect (or desire) to completely replace PCOs. Rather, one should look to this advanced IT to augment and enhance the PCO. This can relieve these key process participants from the routine and perfunctory duties currently required and equip them with the ability to focus their attention and effort on the difficult, unusual, and complex procurement problems more appropriate for their considerable knowledge and experience. Perhaps PCO-oriented processes should be redesigned using something of an "80/20 rule," in which knowledge systems are used for the majority of work (e.g., 80 percent) that is routine and perfunctory, reserving the balance for problems more deserving of PCO attention.

Research along these lines has been ongoing for some time (e.g., at the Naval Postgraduate School) and such intelligent contracting systems are not in the realm of science fiction. Rather, proof-of-concept systems have been constructed through straightforward application of knowledge technology to the domain of military procurement and contracting (e.g., see Nissen, 1999). Further, it is interesting to note the initial SPS specifications included some references to intelligent capabilities. However, there is little in the way of intelligence in the current SPS implementation.

Yet AI technology is well within current capabilities of many universities and some commercial contractors today. Indeed, AI represents the easy part. The difficult task is formalizing the knowledge, which requires expertise in contracting as well as AI. Because few knowledge engineers (e.g., AI professionals) possess in-depth procurement knowledge, and even fewer contract specialists are trained in AI, intelligent-contracting functionality is unlikely to be seen until the next generation of SPS. The requisite technology exists and has been demonstrated. It now remains for SPS officials to investigate knowledge systems and plan for incorporation of this technology into SPS.

#### **INTELLIGENT CONTRACTING AGENTS**

The power of AI and IT does not stop with the kinds of knowledge systems discussed above. Although such static, advisory systems are powerful and offer good potential for dramatic performance improvement in terms of cost and cycle time, still more impressive process redesigns emerge from introduction of intelligent agent technology into the supply-chain process. Intelligent agents are autonomous, network-mobile software entities capable of performing work at various process locations (e.g., in the contracting office, at one or more offerors' sites) and acting responsibly on behalf of their owners with the same kind and level of intelligence described through the systems above. For example, an intelligent contracting agent can be designed to interpret a set of requirements, prepare a regulation-compliant request for proposal (RFP) or quotation (RFQ), identify potential supply sources, and conduct market surveys. Further, these agents can

move to potential suppliers' locations and collaborate with supplier agents to prepare responsive proposals, and then return to the contracting office, summarize the various proposals or quotations received, and make a preliminary source-selection recommendation. The cost and PALT savings possible through this powerful, exciting technology should be obvious.

A newer area of research than knowledge systems above, intelligent contracting agents is more representative of the generation after next of SPS. But laboratory prototypes

exist today that are designed to effect just this kind of supply-chain integration and management. For instance, a prototype set of intelligent sup-

ply-chain agents is being examined in terms of its performance of commercial software acquisition (see Nissen and Mehra, 1998) and agent-development tools are improving with each agent-based academic conference (e.g., see Mehra and Nissen, 1998). Figure 1 delineates the process steps performed by these agents and their path between user, supply, and contractor locations.

Clearly, intelligent-agent technology is not limited to procurement and contracting. For example, an intelligent program management agent can be designed to:

- interpret the software requirements of a major weapon system;

**"...still more impressive process redesigns emerge from introduction of intelligent agent technology into the supply-chain process."**

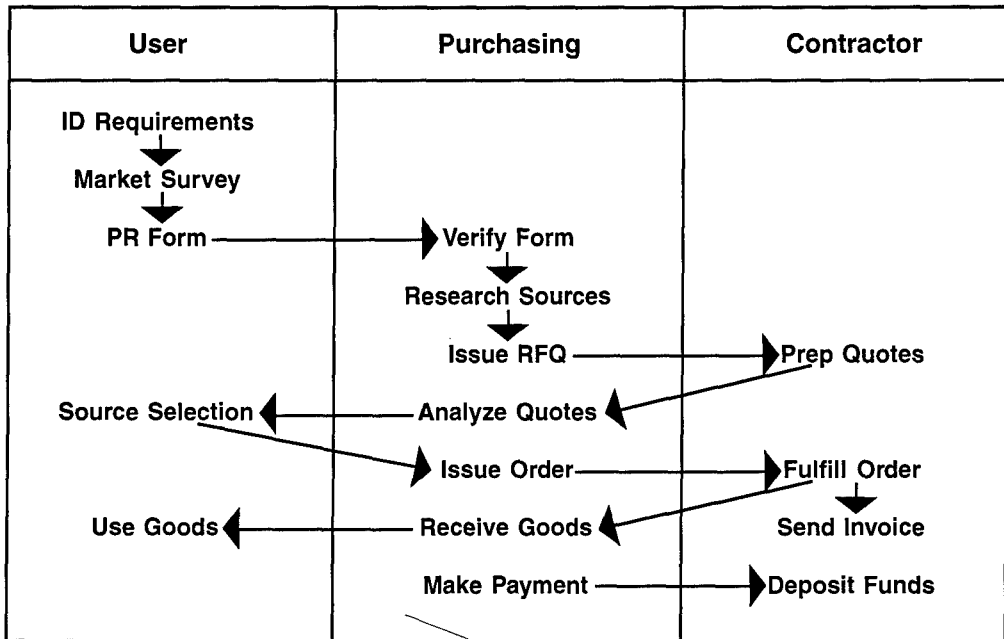


**Figure 1. Software Supply Chain Process**

- analyze the corresponding RFP for inclusion of the appropriate standards, requirements, reviews, and data items;
- evaluate offerors' proposals, software development plans, and past performance data; and
- even interpret post-award performance data (e.g., software metrics, cost/schedule status reports).

Intelligent logistics agents can similarly be designed to analyze deployment plans, monitor external events, advise contractors of likely surge requirements, and even re-plan with changes to world events and the global environment.

This technology can clearly advance the state of the art in electronic contracting,

but it follows directly from, and synergistically augments, current and next-generation IT-enabled process redesigns discussed above. Simulated performance of agent-based contracting processes indicate even more dramatic performance gains in terms of cost, cycle time, quality, flexibility, and other desirable metrics, and prototype performance to date is encouraging. Even graduate students are beginning to involve themselves with this technology through thesis work, and one can anticipate intelligent contracting agents to be ready for the DoD procurement environment far in advance of the DoD being ready for agent-based contracting. Readiness notwithstanding, this represents the future of contracting in the digital age.

## **CONCLUSIONS**

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The Standard Procurement System represents a significant step forward to overcome many severe pathologies associated with the DoD procurement process. However, a number of problems are emerging in conjunction with SPS implementation, and it clearly represents only a humble beginning to advancing the state of the art in electronic contracting. Moreover, simulated process performance studies indicate that although the workflow technology underlying SPS offers good potential for cycle-time reduction, management should anticipate only negligible cost reduction, at best. When training, support, and maintenance costs are included; process cost may actually increase through SPS implementation and operation.

Alternatively, the next generations of IT, incorporating AI technologies, offer potential to dramatically reduce both cost and cycle time of procurement processes and our understanding of such technologies suggests other benefits as well, such

as increased process quality and consistency. The AI technology associated with knowledge systems is now quite mature and has been successfully demonstrated in many domains with great similarities to defense procurement. This study finds that knowledge system tools can be employed to support both contract specialist and PCO work and may represent the next generation of SPS capability. For the generation after next, intelligent agent technology can further streamline, automate, and support procurement and contracting through software representatives that traverse networks to represent buyers and sellers in procurement transactions. With working proof-of-concept systems now being studied in the laboratory, the generation after next of SPS may follow closely behind the employment of knowledge systems. It now remains for SPS officials to investigate and plan for incorporation of these powerful technologies into electronic contracting systems beyond the current SPS.



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# CIVIL-MILITARY INTEGRATION: THE CONTEXT AND URGENCY

*William B. Linscott*

As defense budgets decline, progress in acquisition reform advances, and worldwide emerging threats become apparent, the need is obvious for a strong industrial base to maintain our economic and military strength and retain our position of global leadership in the 21<sup>st</sup> century. It also becomes clear that our success depends on integrating the civil and military sides of industry. We need only change the rules to find that solution.

**T**here are times when the relentless pace of activity surrounding us can disguise the obvious. What should be clear sometimes appears only after it has been placed in a context that will make it stand out. With the fast pace of acquisition reform initiatives commanding our attention today, the concept of civil-military integration (CMI) may be less than obvious. To appreciate CMI, we must place it in the context of today's changing economic and global environment. There are opportunities available through CMI that can produce benefits for defense, industry, and the nation as we position ourselves for global leadership in the 21<sup>st</sup> century.

Recent procurement legislation and other government initiatives have eliminated some of the barriers to a more streamlined acquisition process. At the

same time, the Department of Defense (DoD) continues to struggle with how to modernize weapon systems for the 21<sup>st</sup> century in the face of a defense budget that has declined dramatically in the past 15 years. A significantly downsized defense industrial base is looking for growth, which is hard to find in the defense sector, but is emerging for the civil and commercial aviation and space and communications sectors. The common denominator and solution offered for these pressures is CMI.

## SEPARATION OF MILITARY AND COMMERCIAL SECTORS

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Separation of the military and commercial sectors of industry has been cultivated carefully over time. The laws and

regulations governing the government acquisition process, which were developed to prevent favoritism, promote public policy, and ensure proper use of the taxpayers' dollars through best-value solutions, are unique. They require the contractor to develop complex, sophisticated business systems to comply with government requirements for cost accounting, the Truth in Negotiations Act (TINA), and government property accountability, among a myriad of others.

Participation in the government defense business, therefore, comes with an added expense for these compliant business systems, as well as exposure to scrutiny and unique legal liabilities not neces-

**"During the Cold War years, the United States had a strong defense budget."**

sarily found in the commercial business world. The added expense is one that is not required for commercial busi-

nesses and is a burden that can affect a contractor's competitiveness. As a result, many companies choose between participating in the commercial and defense business sectors. Other companies choose to participate in both sectors, separating their defense and commercial businesses into different segments within the company and creating separate business systems to meet government requirements.

The costs of these unique requirements are included in the price of products and services purchased by the government. For example, the 1994 Coopers & Lybrand study on the defense regulatory cost premium assessed the cost of compliance with unique DoD requirements at 18

percent. This premium is passed on to the government in the costs of defense.

## DECLINING DEFENSE BUDGET

During the Cold War years, the United States had a strong defense budget. This environment changed quickly with the fall of the Berlin Wall in November 1989. The Soviet Union ceased to exist and with it the significant threat to global peace. Democracy and capitalism were introduced into Eastern Europe and the Confederation of Independent States (CIS). The United States was left as the remaining superpower.

The absence of the Cold War caused a reevaluation of evolving defense threats, with a corresponding redefinition of defense roles and missions. In addition, there has been a balancing of national interests throughout the budget process of the 1990s. The defense portion of the budget has declined, giving way to other national needs and priorities. Figure 1 provides a breakout of the allocation of the fiscal year 1999 budget dollar (Office of Management and Budget, 1998).

From the high point in 1985, with President Ronald Reagan's commitment to rebuild the United States' military strength, the purchasing power of the defense budget had fallen steadily from approximately \$420 billion to around \$255 billion in fiscal year 1999 ("DoD Asks \$4B," 1999). The recent relatively minor increase proposed in the DoD budget for fiscal year 2000 represents the first real military spending increase since the Cold War. Figure 2 shows the defense budget in fiscal year 2000 dollars from 1980 through 2005 in 5-year increments ("DoD Asks \$4B," 1999).

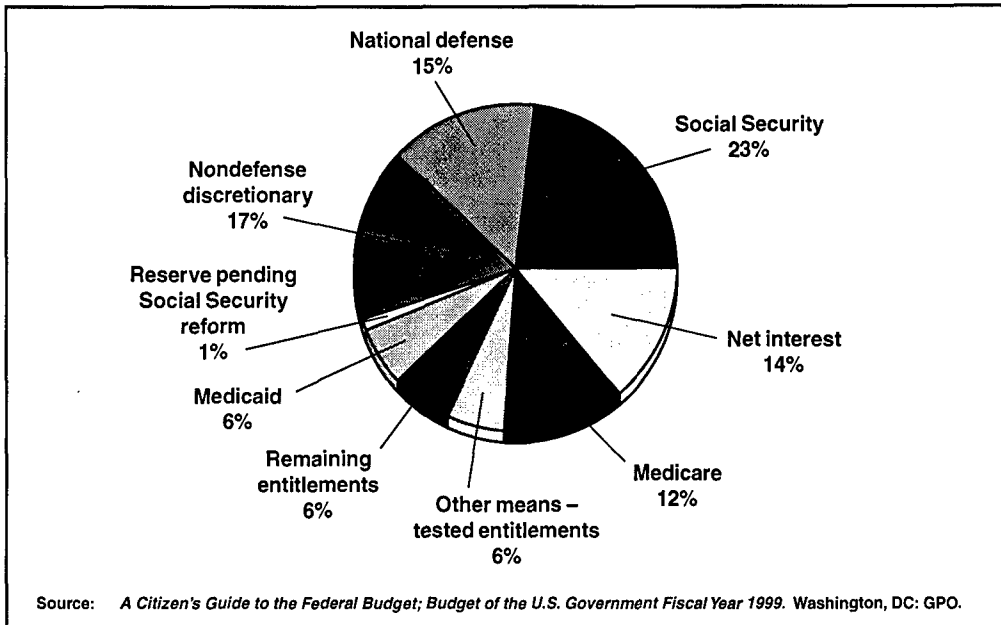


**Figure 1. Fiscal Year 1999 Budget Dollar Allocation**

## **ACQUISITION REFORM**

The decline of the defense budget (particularly, funds for modernization) and, in turn, the downsizing by the defense

industry resulted in pressure to manage with less and established a clear need for acquisition reform. The desire for new ways of doing business focused on doing things "faster, better, cheaper," and the government

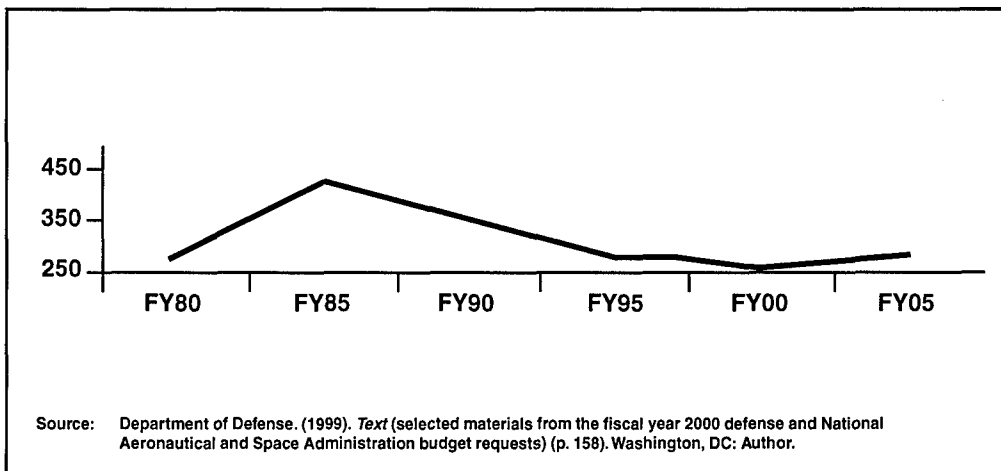


**Figure 2.**  
**The Defense Budget: From Fiscal Year 1980 to Fiscal Year 2005**

procurement rules and regulations began to change.

In 1993 the Section 800 Panel (that is, the DoD Acquisition Law Advisory Panel mandated by Section 800, Public Law 101-510) articulated the basic concept and framework for acquisition reform (DoD, 1993). It also provided in its 1,800-page report recommendations for specific changes that must be made to bring about meaningful reform in defense procurement. The panel's overall recommendation can be summarized as a move from the traditional procurement system, which

**"The bottom line for acquisition reform for both government and industry is to reduce costs, while providing superior weapon systems to the war fighters."**

emphasized oversight and unique requirements, to a new approach with emphasis on efficiency and effectiveness. This new approach also included a preference for use of commercial products

and services and commercial practices.

Acquisition reform made substantial progress through the first half of the 1990s, culminating in the Federal Acquisition Streamlining Act of 1994 (FASA) and the Clinger-Cohen Act of 1996. At the same time, DoD became a world class buyer of goods and services from a more global marketplace. The bottom line for acquisition reform for both government and industry is to reduce costs, while providing superior weapon systems to the war fighters.

## CIVIL-MILITARY INTEGRATION

CMI is both a driving force in acquisition reform and a product of acquisition reform. It is a concept that advocates bringing together the commercial and military sectors of industry, so both commercial and military work can be performed in a common facility using commercial processes and practices. CMI addresses two major concerns—the erosion of the traditional defense industry that resulted from downsizing, and the need to sweep in commercial sector companies that produce technology and products that could be leveraged for defense purposes. With a strong defense industrial base, competition can be increased; and using best-value solutions can provide affordable products and services.

In addition, using commercial practices requires less government oversight and, therefore, reduces the government's infrastructure costs. CMI also allows companies to bring together company-wide assets and resources that otherwise would be separated by type of work. The resulting efficiencies reduce operating costs and overhead. In addition, there is an ability to provide the best solutions for commercial and government customers alike.

## BARRIERS TO CMI

The changes brought about by FASA and the Clinger-Cohen Act have removed significant barriers to selling some items produced by commercial companies. However, these changes were narrowly drawn to address buying commercial items, not utilizing commercial capability or capacity for military-unique items.

There still are limitations when building a military item (that is, a purely military item—not a modified commercial item) on a commercial production line or processing it through a commercial facility. An example of this could be found in a large company with both government and commercial segments. The government segment might have a requirement for building government tooling and would like to utilize its commercial segment. The commercial segment has the capability and capacity to produce the tooling. It builds its own tooling in support of its own production needs. However, since the tooling is uniquely military and tooling is not a product line that is offered for sale to the general public, it does not fall within the Federal Acquisition Regulation (FAR) commercial item definition.

This situation also can occur if a company develops a military-unique item and would like to produce it using a commercial process or test facility. Again, this is an available capability, but since it is not a service offered to the general public, it fails to meet the FAR definition of a commercial item. If it does not fit the commercial item definition, the commercial company or segment cannot be relieved from government requirements and terms and conditions, and the government is unable to effectively access the commercial capability.

An avenue is needed to gain access to these commercial opportunities, because commercial capability and capacity can provide best-value solutions. These companies can perform the work, but they encounter barriers in requirements, which demand differing business systems necessary to address unique government requirements. These include:

- pricing and estimating system requirements for cost collection and rate development and application;
- Truth in Negotiations Act (TINA) requirements for submission and certification of cost or pricing data;
- procurement system requirements for approval, compliance, and supplier flowdown, plus domestic source preference requirements;
- government property accountability and material management and accounting system (MMAS) requirements;
- cost accounting standards (CAS) disclosure requirements and requirements for estimating, accumulating, and allocating costs;
- reporting systems to address unique government requirements (socioeconomic, environmental, etc.); and
- management systems that support interaction with government oversight (metrics, audits, record retention, etc.).

To attract commercial interests to defense contracting, there also must be relief from traditional contract clauses. More progress—both legislative and regulatory—is needed to remove these barriers before CMI can be achieved.

#### **REMOVING MORE BARRIERS**

Moving forward to complete implementation of CMI will require additional change. Some significant areas include:

**Commercial item definition.** The commercial item definition needs to be rewritten to clarify the definition of commercial services. Both the criteria for establishing that the "substantial quantities" requirement has been met and the interpretation precluding use of labor hour, time and materials, or similar contracts when purchasing commercial services need to be revisited. In addition, the commercial item definition should be modified to include all products and services produced by a "commercial entity," defined as an enterprise for which a substantial percentage of sales is commercial.

**"The key to participation by commercial companies is being able to avoid the impact of government requirements."**

DoD and defense contractors should have this latitude to provide best-value solutions. The key to participation by commercial companies is being able to

avoid the impact of government requirements. Allowing commercial companies greater access to the commercial acquisition procedures of FAR Part 12 is essential.

**Cost accounting standards and Truth in Negotiations Act.** Both of these uniquely government requirements receive a great deal of attention as significant barriers for commercial firms. Both need new rules of applicability or broad waiver authority so they can be removed quickly when there is a best-value business case.

**Unique business systems.** Application of unique and complex business systems to address transactional records, cost collection, accountability, and demonstration

of system compliance can impose significant cost to the operations of a commercial company. Acceptance of commercial or industry standards should be encouraged. For example, today we find ISO 9000 becoming the industry standard for quality. ISO 9000 requires deployment of a process for a quality system, coupled with a certification review process, and a continuing process for sustaining the standard. A somewhat similar approach is used for the software development standard established by the Software Engineering Institute (SEI) capability maturity model. (This activity involves DoD, industry, and academia.) This movement toward use of industry standards is a significant step toward promoting full implementation of CMI.

**Prime contractor empowerment.** Affordable weapon systems most likely will have significant commercial components, subsystems, and even software. To enable the shift to greater commercial application in military products, the prime contractor should be empowered and tasked to integrate best-value commercial solutions into the end item. This should be accomplished without fear of being second-guessed as to whether the commercial item "rule" has been applied correctly, since it can be subject to different interpretations.

**Other barriers.** There are many other barriers that are of significant concern to commercial firms. Examples include requirements for certifications, representations, and other similar statements; application of the Civil False Claims Act (with its higher standard of proof for fraud); and requirements for domestic source preferences. Based on an earlier Coopers & Lybrand study, DoD identified

a list of 59 cost drivers. The top 10 cost drivers were the DoD Quality Assurance Program requirement; TINA; cost and schedule control system criteria (C/SCSC); configuration management; contract-specific requirements and statement of work (SOW); Defense Contract Audit Agency/Defense Contract Management Command interface; CAS; MMAS; engineering drawings; and government property administration (Coopers & Lybrand, 1994; Soloway, 1998). The difficulty in formulating a complete list of barriers is that each company is different and, therefore, affected differently by government requirements. However, these requirements must be challenged and eliminated if complete CMI is to be achieved.

#### **WHO BENEFITS FROM CMI?**

**The defense benefit.** DoD is looking for savings from within the defense budget. These savings are to be produced from new ways of doing business that are less expensive and reduce cycle time. The savings would be used to fund DoD modernization of defense weapon systems. DoD already has launched a "revolution in business affairs," for which Jacques Gansler, Under Secretary of Defense for Acquisition and Technology, has established priority actions (1998, June 1). It is in this plan of action that we find the initiative for CMI:

- Aggressively pursue full implementation of acquisition reform.
- Bring about far greater civil and military integration.

- Shift the major share of resources from infrastructure and support to modernization and combat.
- Reengineer the DoD logistics system and reform its management systems.
- Train and educate the acquisition work force to meet the demands of reengineering.

The changes contemplated by CMI will offer DoD an opportunity to broaden the defense industrial base, gain access to commercial technology and development, and reduce the cost of defense.

Lower costs will come from using commercial practices and avoiding government-unique requirements.

It also will come from reduction in government oversight, which is not needed for commercial contracting since the marketplace provides checks and balances. The result is a more affordable means of providing for the national defense. DoD also views CMI as a way to continue to develop its active partnership with industry. This will open more doors for advanced technology solutions for defense needs.

**The industry benefit.** Industry has downsized in response to the reduction in the defense budget. The effect has been dramatic. The defense industrial base of nearly 50 major prime contractors shrank to five major contractors between 1980 and 1997, as a result of numerous mergers, acquisitions, and other business

**"Industry has downsized in response to the reduction in the defense budget."**

consolidations (Credit Suisse First Bank, undated). The traditional defense companies made conscious decisions to either stay in the defense market or move to the commercial market. Those leaving sold the defense portions of their businesses. Those remaining are positioning themselves through acquisitions, mergers, and other business strategies to increase market share and compete for the defense dollar.

The U.S. aerospace industry has annual sales of \$140.5 billion spread among three segments of the industry—military defense, space and communications, and civil and commercial aviation (“Aero-

space Industry,” 1998). Industry is looking for growth and return to provide shareholder value. But those in the defense business will have trouble finding growth

**“It is apparent, however, that the most dramatic growth is occurring in the space and communications market.”**

in the U.S. military defense market. Growth in this area will be achieved by capturing market share from other competitors. Foreign military sales may provide some additional opportunities, but this area has its limitations, since the reduction in defense spending is not limited to the United States. In addition, there are strong foreign competitors looking for market opportunities. The foreign marketplace also has its own pitfalls, such as the potential for an unbalanced playing field due to foreign policy considerations and national interests.

The civil and commercial aviation market shows growth, but continues to run in cycles with erratic patterns driven by world

economic conditions. At the moment, we are seeing a record number of commercial airplane deliveries. Even though other elements of the world economy are struggling, this segment of the market currently is enjoying growth. It is apparent, however, that the most dramatic growth is occurring in the space and communications market. Today, the space and communications market is approaching one-third of the total aerospace market and is nearly equal to the other market segments (civil and commercial aviation, and military). The growth in this market cannot be ignored. Aerospace companies are entering the market to provide satellites, launch vehicles, and ground operations, among a myriad of other related services and products. With the tremendous growth in investment in the U.S. commercial space market (estimated at a half trillion dollars to be spent in space between 1996 and 2000) and an estimated 1,500–1,800 satellite launches to be made in the next 10 years, commercial space becomes an obvious target for business opportunities (Aerospace Industries Association, 1999).

These growth areas—civil and commercial aviation, and space and communications—are predominantly commercial business opportunities. For defense contractors to grow, they will have to enter and compete in these sectors. To compete, they must be able to shed the burdensome government-unique business systems and practices carried over from their defense heritage. If they cannot or do not, their success may be jeopardized. Moving forward with CMI will allow contractors to migrate to commercial practices and business systems. This, in turn, will create synergy with commercial growth opportunities and leverage efficiencies and cost

reduction for both government and commercial customers.

Therefore, CMI is a critical element in preparing industry for the mixed defense and commercial marketplace evolving around us today. CMI not only is an opportunity to attract new commercial firms to the defense industrial base, but also is necessary to assure that those already there will stay and, at the same time, have good opportunities for growth.

**The national benefit.** The aerospace industry produces high-tech jobs. It provides technology and products that create collateral technological growth and that have application across a wide variety of industries. These are the types of jobs and the kind of industry that created the standard of living that most Americans have come to appreciate and expect. The aerospace industry, also, is a key element in maintaining the United States' balance of trade. In fact, aerospace exports are the most significant positive factor in our country's balance of trade. In 1997, aerospace exports, imports, and trade surplus were at a record high. The U.S. aerospace industry reported a trade surplus of \$32 billion ("Aerospace Trade," 1998).

The health and welfare of a nation reside with its economic strength. To quote Lester Thurow (1992):

History is clear. While military power can sometimes outlast economic power for centuries, eventually military power depends upon having a successful economic base.

With the leadership role that the United States will carry into the 21st century, it is essential to the national interest that we

continue to lead the world in aerospace technology, production capability, and services. It is from this industrial base that we will provide for defense needs and sustain a healthy economy for the future.

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### **THE CASE FOR URGENCY— THE EMERGING THREATS**

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The defense threats predicted for the 21st century are, in fact, emerging today. Under Secretary Gansler has addressed these emerging threats when speaking to government and industry (1998, June 22):

Early 21st century warfare will be dramatically different. ... [We] face a world where individual terrorists, transnational actors, and rogue nations can unleash firepower in many ways as terrifying as that of a major global power—and perhaps even more likely. These are not disorganized bands of political zealots armed with pistols and hand grenades. Today's threat comes from well-organized forces, armed with sophisticated, deadly weapons (often purchased on the world arms market), with access to advanced information and technology (often available commercially), the skills to use them (or the ability to purchase the skills), and few moral inhibitions about their use.

Those potential threats are with us now—the threat of weapons of mass destruction in Iraq, emerging nuclear capability in Pakistan and India, advanced

missile tests by North Korea, and the recent U.S. embassy bombing by terrorists in Africa. There is an immediate need for development and deployment of deterrence for 21st century threats. Therefore, the ability to produce funding out of savings from the revolution in business affairs is extremely important. We all need to contribute to the savings today.

There also is an urgency regarding America's industrial competitiveness. A competitive disadvantage is created by continuing to separate commercial and defense business. Companies need to be in a position to apply their entire resources to providing "best-value" solutions for their customers—regardless of whether the solutions are for commercial or government application. There is no guarantee that U.S. industry will maintain a leadership role in the aerospace market. Recent history demonstrates that leadership in the competitive global market can change hands quickly. Let us remember what we have seen happen to our world market share in some other

major industries, such as steel, automobiles, consumer electronics, machine tools, and semiconductors.

No day should pass without these factors uppermost in our minds. We should feel the pressure.

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## **CONCLUSION**

Government and industry have been reshaped and redefined in the 1990s. In consonance with these changes, we need to continue our progress with CMI, acquisition reform, and other elements of the DoD revolution in business affairs.

Our success in the future depends on our decisions today. At stake, as industry positions itself for global competitiveness and the country positions itself for continuing global leadership, are a superior national defense and a strong economy. The nation is counting on the leaders in government and industry. We should make decisions and change the rules when it makes sense. CMI makes sense.



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# **ACQUISITION REVIEW QUARTERLY**

## **GUIDELINES FOR CONTRIBUTORS**

The *Acquisition Review Quarterly* (ARQ) is a scholarly peer-reviewed journal published by the Defense Acquisition University. All submissions receive a masked review to ensure impartial evaluation.

inquiry into a significant research question. The article must produce a new or revised theory of interest to the acquisition community. You must use a reliable, valid instrument to provide your measured outcomes.

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### **SUBMISSIONS**

Submissions are welcomed from anyone involved in the Defense acquisition process. Defense acquisition is defined as the conceptualization, initiation, design, development, test, contracting, production, deployment, logistic support, modification, and disposal of weapons and other systems, supplies, or services to satisfy Defense Department needs, or intended for use in support of military missions.

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### **RESEARCH ARTICLES**

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

We publish Defense Acquisition research articles that involve systemic

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### **MANUSCRIPT SECTIONS**

The introduction should state the purpose of the article and concisely summarize the rationale for the undertaking.

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 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**

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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?
- Did you build needed controls into the study?

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

## **CRITERIA FOR TUTORIALS**

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Tutorials should provide special instruction or knowledge relevant to an area of defense acquisition to inform the Defense Acquisition Workforce.

Topics for submissions 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.

## **OPINION CRITERIA**

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Opinion articles should reflect judgments based on the special knowledge of the expert. Opinion articles 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, opinion pieces should clearly express a fresh point of view, rather than negatively criticize the view of another previous author.

## **MANUSCRIPT STYLE**

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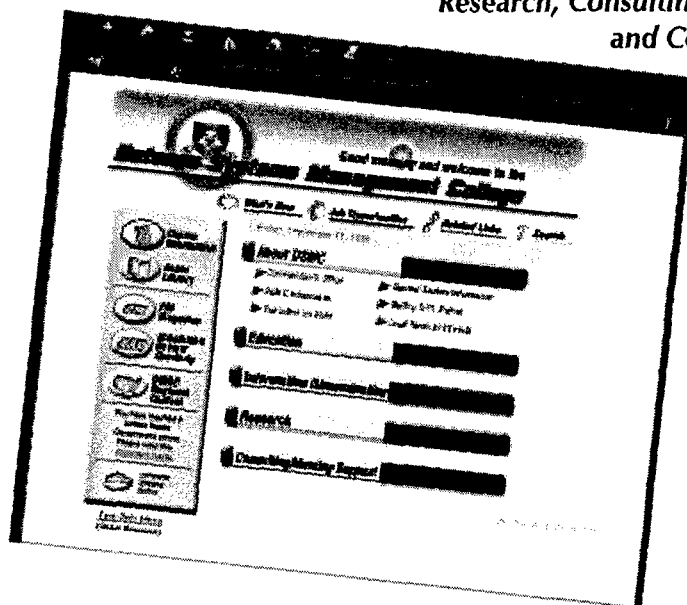
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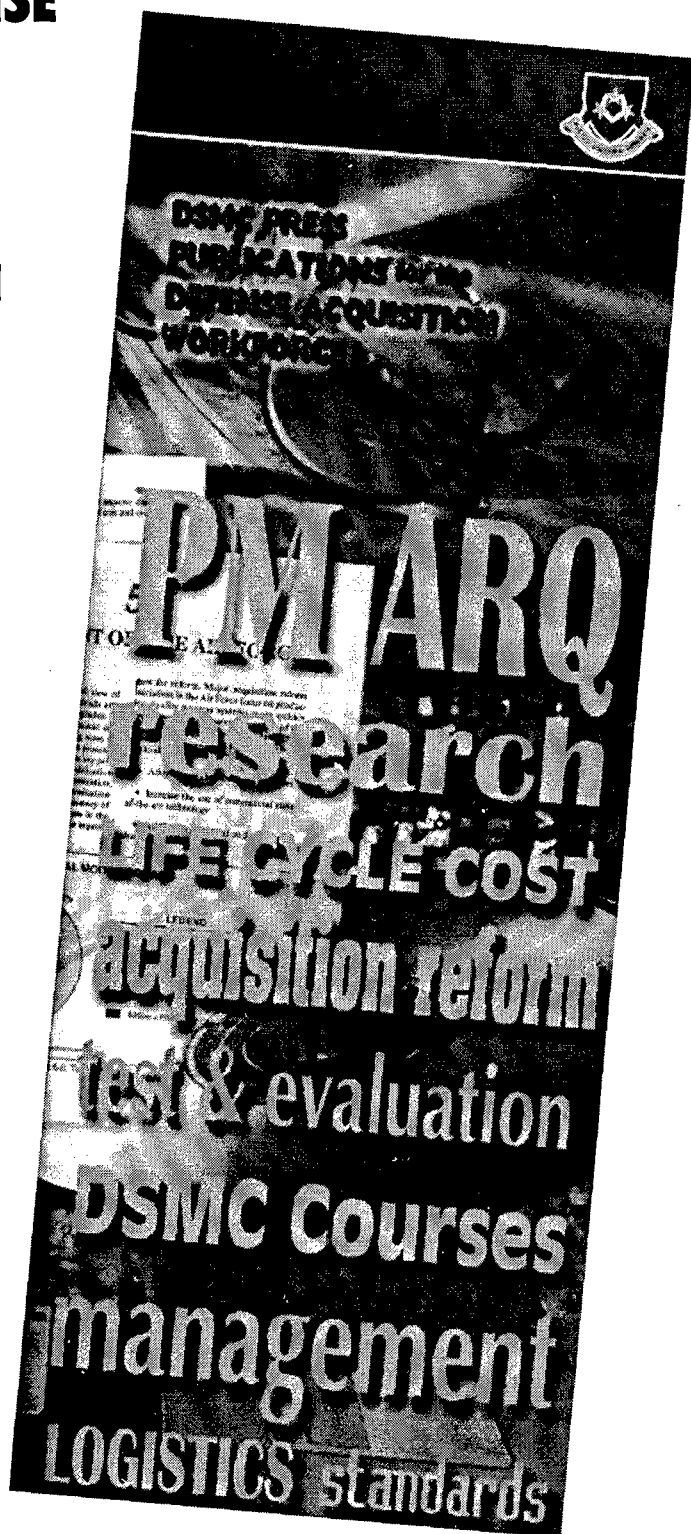
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# **ARQ SURVEY RESULTS ARE IN!**

Thanks to those who responded to our recent, random survey of 2000 ARQ readers. Now that we know what is on your mind, we want to share this with the rest of our readers as part of our product improvement.

## **AUTHORS!**

### **OUR READERS WANT TO KNOW ABOUT THESE SUBJECTS**

We received many suggestions for future topics, and we hope that our readers who are subject-matter experts will author future articles to benefit the rest of the acquisition community. So warm up your computer keyboards!

- Information technology and AIS
- History of downsizing and the impact on the warfighter
- History of outsourcing, and the quality and cost results
- COTS, especially in IT systems
- More Navy and Army perspectives to balance numerous Air Force articles
- More real-life examples from the school of hard knocks
- Competitive sourcing, and the A-76 process
- Past value and past performance tradeoffs
- More C4ISR acquisition articles
- More case studies—what worked, what didn't, relevant data, author's conclusions
- Point/counterpoint articles—more opposing viewpoints
- More theme issues, announced in advance, like the Naval Postgraduate School special issue
- Innovations in the workplace.

General comments we are not considering at this time...

- Make ARQ a monthly or bi-monthly publication, versus quarterly
- Print it a larger size (8 ½ x 11 has been suggested)
- Provide it in CD-ROM (note that it's already on the DSMC home page at <http://www.dsmc.dsm.mil>)
- Publish more, shorter articles (we publish shorter articles in *Program Manager* magazine)
- Add black and white or color charts, photos, and art (we are now including photos but inside color is not an option for us at this time).

## **HOW YOU CAN HELP**

- E-mail your additional opinions to [caruthg@dsmc.dsm.mil](mailto:caruthg@dsmc.dsm.mil)
- Write on any of the above topics
- Suggest additional themes, authors, or articles
- Volunteer your organization to co-sponsor a future theme issue.

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