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JOURNAL OF THE DEFENSE SYSTEMS

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ou are now well prepared for the rough and tumble of bureaucratic politics, having survived 5 months of academic politics. I am sure you can now appreciate C. P. Snow's quip that academic politics are most vicious, but the stakes are so low.

I know you are anxious to get on with your assignments, where the stakes are not at all low, and to put to work all you have learned here: to leave behind long and rigorous days of learning for the normal life of a program manager; to relax with the 70-hour work weeks that are the norm for the DOD program manager; to leave behind nights spent in the library poring over textbooks in favor of a pleasant evening perusing a mere five pounds of contract documents and a three-foot-high stack of briefing charts.

I am sure you are anxious to meet the people you will work with—auditors, inspectors, investigators, congressional staffers, headquarters people, and others who will arrive with a smile and a cheerful greeting: "Hi, we are here to help you."

I imagine you are eager to test your program manager skills—to find out how good you are at writing "viewgraphs," and how deft at making last-minute changes that are the lifeblood of the management-by-viewgraph crowd.

You have all these things to look forward to: countless frustrations and myriad problems—problems even the Defense Systems Management College did not prepare you for. That is the immensely challenging and difficult role of the program manager. If there is any job in our government that makes a direct and sizeable contribution to the defense of this nation, this is it.

Better than most, you know our defense is underwritten by the *quality* of the *weapon systems* we provide to our combat forces. We rely on our ability to equip America's defense forces with the high-quality military systems needed to deter a numerically superior adversary. You have been chosen to share that enormous respon-

sibility. You have been selected for positions that will allow you to influence directly the efficiency of our acquisition system and the weapons we acquire.

Today, as you graduate from the school that Dave Packard set up some 15 years ago, the only college of its kind in the Free World, I want to talk a little about being a program manager—about the challenge ahead and the nature of the business you are about to enter.

At the Defense Systems Management College, you have not just studied management. You have examined leadership and developed an understanding of the importance of both functions to the success of the defense acquisitions system. The Defense Systems Management College teaches that professional acquisition managers must appreciate both disciplines and the qualitites associated with each. Program managers must manage things and lead people.

Some people have not understood the importance of both functions to the defense acquisition system. According to these arm-chair strategists, the military's emphasis on management was responsible for all problems throughout our defense establishment, whether real or merely perceived.

Within acquisition, there were problems. The indefensible prices that a few companies were proposing to charge, and that we found when we came, reinforced the criticism of the so-called "reformers." No one seemed to remember that we had found those
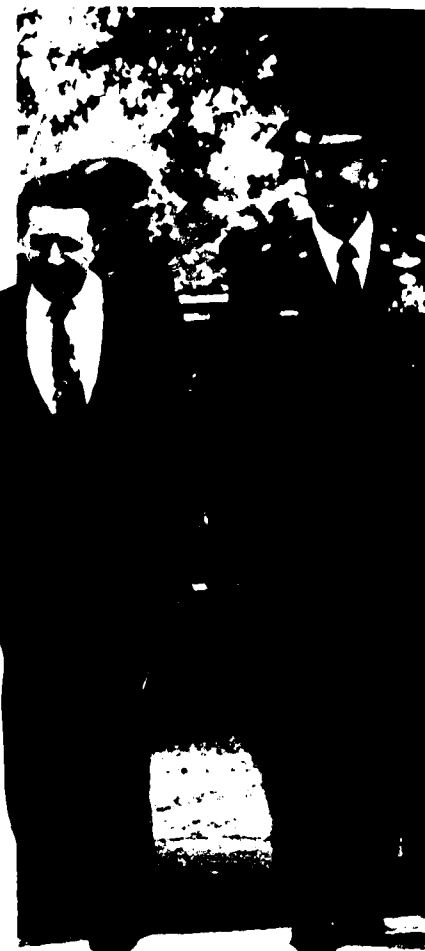
Secretary of Defense Caspar W. Weinberger and Brigadier General Charles P. Cabell, Jr., USAF, DSMC Commandant arrive for PMC 87-1 graduation, Fort Belvoir, Va.

prices and *refused* to pay them. Our management has been dissected and examined in infinite detail. Every major "think tank" has cashed-in on the trendy demand for studies of our acquisition management, which really means they simply joined the attack. We now have results of the President's Blue Ribbon Commission on Defense Management, a host of internal DOD studies, and legislation that has come so quickly that we could hardly implement one law, before the Congress was writing another.

We should not minimize the inherent and historical problems in acquisition management. In fact, I directed a major review and reform of acquisition practices shortly after this Administration took office. It was clear that our managers—the men and women who manage our acquisition

system—were not the problem. It is reassuring to note that all of the studies of our acquisition system reaffirmed the skill and dedication of our acquisition people.

I have told everyone who will listen that it is the dedicated, professional acquisition managers who found and fixed most of the problems in our acquisition system. A brief review of what are now popularly called "reforms" testifies to the quality of leadership of the acquisition community.

Much of what we are trying to do today is to manage "things" so that our leaders can operate more freely and effectively. The "enterprise" programs, acquisition streamlining, model installations, professional education for acquisition personnel, show we believe that the real solutions to acquisition problems are to remove barriers to creativity and to foster an environment of encouragement and trust.

We have adopted many other initiatives to give our people more effective tools. Among these are: multi-year procurement; baselined acquisition programs; a focus on quality that goes beyond performance to include the whole range of factors that determine the value of our hardware to the soldier, sailor, and airman in the field; reduction of military specifications; off-the-shelf procurement; cooperative R&D with allies; 2-year budgeting; contractor self-disclosure programs; use of suspension and debarment proceedings; and the most extensive and pervasive audit of defense programs ever undertaken.

These are correctly cited as the solutions to our management problems of the past. But what is not heralded, what remains virtually unknown is that these dynamic, cost-reducing programs were not the creation of the "gurus" in the think-tanks or the products of rounds of congressional hearings, but of the vision and professionalism of our acquisition managers.

Baselining, for example, is rooted in an Air Force Systems Command initiative dating from 1982. In fact, some correctly credit the President with establishing the first baseline—on the B-1 bomber. Two-year budgeting is another recently discovered idea, but it has been in my speeches and testimony since early in my tenure as Secretary of Defense.

Clearly, the desire for excellence that underpinned the dynamic improvements underway within the defense acquisition community are not indicative of impoverished leadership or a self-serving bureaucracy. The defense acquisition system, despite historic problems and the need for reorganization now underway, is run by extraordinarily dedicated and capable people. I particularly want to call your attention to the extraordinarily able record of our new Undersecretary for Acquisition who is in charge of the whole acquisition process.

I will not pretend that we did not have problems in acquisition. I am sure some problems will always be with us. But the problem was not with the dedication and quality of our people.

As you graduate from the Defense Systems Management College today, I want to remind you of this. In joining or returning to the defense acquisition management team, you will become part of a highly-regarded group of professionals. I am one of those whose high regard you have.

There is no negative connotation to the title of manager in acquisition. Rather, we properly understand that a manager's duty is an expression of leadership responsiblility.

In America's military, we value the successful leader above all else. And the defense acquisition system is no different. The real job of the program manager is no different than that of any other officer of the government, whether a civilian or uniformed officer. The job is the same: to lead. Your responsibility as acquisition managers is to lead a diverse team of professional men and women in accomplishing your portion of the defense mission which is providing our armed forces with high-quality military equipment.

Leadership has as much bearing on the success of the program manager as it does on the success of a combat commander. So your challenge is to be a leader, to mark the proper path for your subordinates, colleagues, and, in your case, contractors. Your challenge is to attain the very highest standards of excellence and to demonstrate an unwavering commitment to absolute integrity.

These two qualities of leadership will determine your success as a program manager. Absolute and unbridled commitment to excellence and integrity are the ingredients for success.

As leaders of the acquisition arm of defense, you must be just as committed to leading by example as is the Wing Commander who flies lead in the first wave, the Battalion Commander at the front line, or the Ship's Captain on the bridge. The very high standards you demand of yourselves as of all military officers and public servants are the standards that must be emulated within the acquisition community.

I hope you can approach your acquisition duties in this way. There is no secret to success as a program manager—whether you are an officer, civilian, or member of industry. Each of us must excel, must lead, and must be above reproach.

Your daily activities, though couched in the lexicon of the businessman, must be governed by the creed and dedication of soldiers and officers.

Your duty and mission is quite simply the acquisition of the combat capabilities that will keep this nation free. Your honor will be your most prized possession. It will sustain you in the severe tests ahead and serve as the foundation for unyielding integrity, the hallmark of the defense acquisition manager. Your daily activities must demonstrate the urgency of the nation's defense today, and your responsibility for the defense of tomorrow.

This is a time of great challenge for the defense acquisition community. Never before has there been a greater need for good ideas, nor an acquisition system more responsive to those ideas. Our reorganization of defense acquisition, our appointment of a highly-qualified man to be in charge of the whole system, have eliminated barriers between program managers and decisionmakers and given you the leverage needed to put good ideas into action.

Today, your creative management is needed even more than before. Our Fiscal 1987 defense budget is 7 percent in real terms below the fiscal year 1985 figure, and the Congress is still slashing away at the Fiscal 1988 budget. The best efforts of the acquisition com-

munity are urgently needed to ensure the American people receive the *fullest* measure of defense from every acquisition dollar spent. To do less will compound the risk our nation faces in a world hostile to freedom.

You will be severely tested to maintain the quality, stability, and affordability of your programs in the years ahead. You will have a central role in our effort to maintain the momentum of defense modernization.

In the last 5 months, the Defense Systems Management College has attempted to prepare you for the very difficult years ahead. I have no doubt it has given you a sound foundation for success in the future. Your relationship with DSMC must not end today. This College can and will continue to contribute to your individual success and the quality of our acquisition system. Through the College regional centers and other programs, your education will continue. Perhaps even more importantly, the resources of this outstanding institution will be available to you. The College's expanding research efforts and the considerable talent of the faculty and staff are committed to assist in your pursuit of excellence in defense acquisition. I urge you to take advantage of those resources, just as I urge the College to continue building its outreach programs in all acquisition activities. The challenge ahead is so great and the stakes so high that we cannot afford to ignore this avenue for further improvement

I hope this graduating class and the faculty and staff of the College will build on your accomplishments. Defense acquisition has made progress in its effort to improve America's defenses, but we must go even farther—and we must do so together.

Let me congratulate you all. Your graduation from DSMC certifies your readiness for the most difficult positions within the department's acquisition community and marks you for even greater challenges. You, and your families, should be very proud of this accomplishment. It is my privilege, as I know it is Dick Godwin's, to congratulate you on your graduation today. ■

"A man's judgment is no better than his information."

Author Unknown.

A survey course on procurement for program office personnel.

This one-week course is designed to provide an overall understanding of the systems acquisition contracting process from planning for a solicitation through contract closeout. It concentrates on key activities required to award and administer a government contract. Included are such topics as program manager/contracting officer relationships. acquisition planning. structuring contracts. request for proposal preparation. cost proposal evaluation. source selection. modifications, DOD cost principles. contractor profit, subcontract management and contract administration.

Lecture-discussions are punctuated with short case studies to reinforce student learning. CMPMC has been designed primarily for DOD personnel working in a program management office or related supporting activity. Military personnel in grades 0-2 and above. and DOD civilians in grades GS-09 and above are the intended audience. Individuals with similar positions in other federal agencies or the defense industry are also encouraged to attend.
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TAKING A BETTER AIM AT

MEASURES

John E. Liston

long with increased emphasis on defense has come an increased emphasis on keeping defense costs down.

Control of escalating cost of government developments and elimination of cost overruns are prime concerns of the program managers (PMs) for system, subsystem, and component developments during all phases of the acquisition process. One of the prime considerations in controlling cost growth is letting contracts initially at realistic target cost with known cost risk. Therefore, evaluating proposals for cost realism becomes an important part of the cost-control process. The task of evaluating proposals for cost realism may be more difficult for early development phases—proof of principal, concept development, technology validation—than later phases, due to substantial technology uncertainty and program risk. However, the approach proposed in this paper would apply to any phase. It was developed and utilized during the Exoatmospheric Reentry-Vehicle Interceptor Subsystem (ERIS) Source Selection Evaluation Board (SSEB) selection process for the Functional Technology Validation (FTV) contract award.

The Problem

This paper is about the source selection cost evaluation process for cost reimbursable contracts with particular emphasis on the evaluation process for measuring cost realism of competitive proposals. The objective is to assure more realistic contractor cost proposals and contract awards at more realistic target costs. The problem is what to use as the standard against which the cost realism of the proposals is measured and how to measure cost realism.

Traditional Approach

The traditional approach in request for proposals (RFPs) and SSEB proposal evaluations require offerors to provide a cost proposal with a target cost and proposed fee arrangement. Therefore, his proposal is a proposed program, and a proposed schedule and a proposed target cost. Then, usually the SSEB has a government point estimate of what the effort should cost. Now the simplest approach to measuring cost realism would be to compare
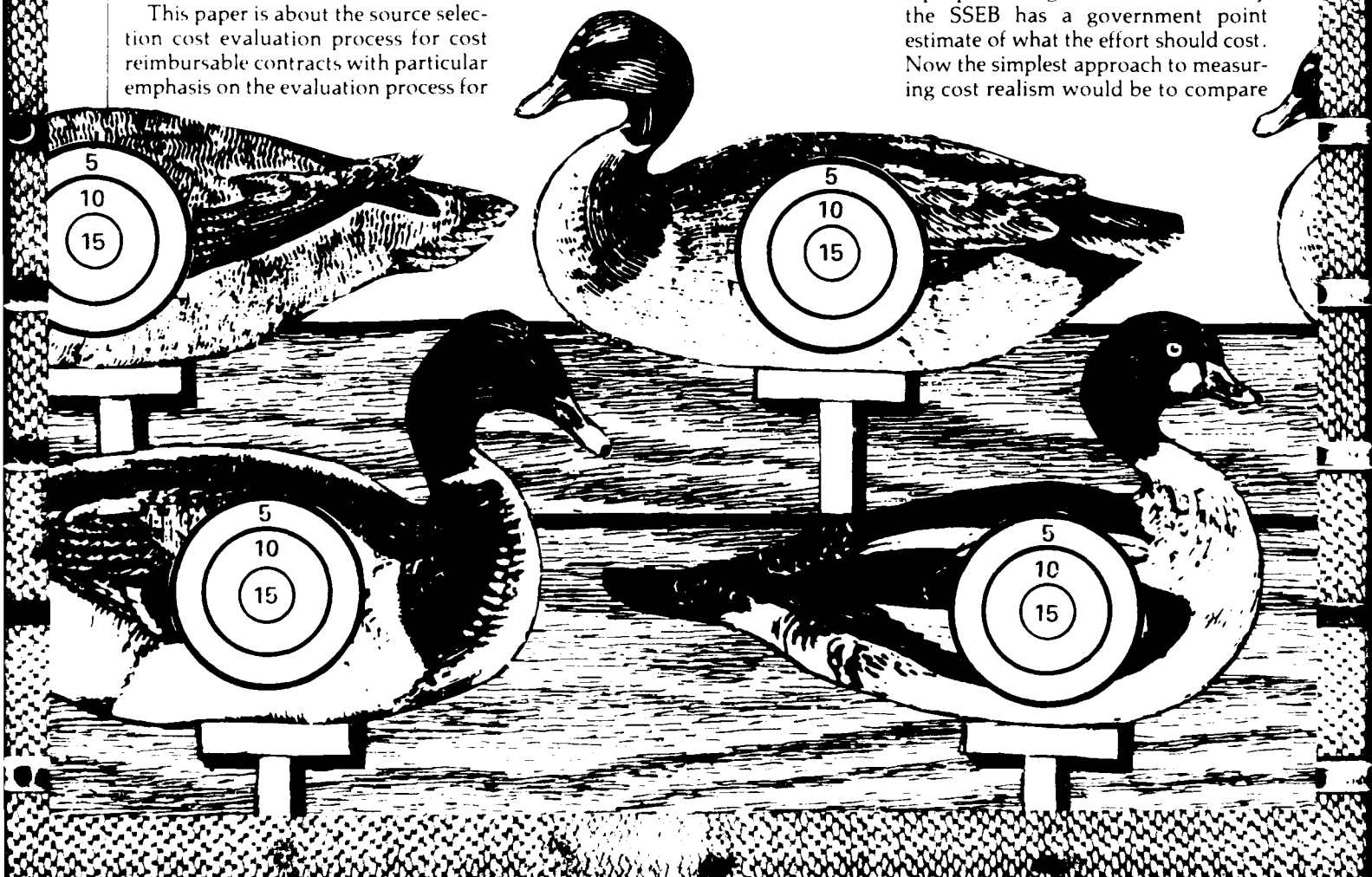
the proposed target cost with the government estimate. In this paper, I suggest that this is not a very good approach and propose that a different method be utilized.

Shortcomings of Traditional Approach

The traditional SSEB approach has several problems.

—All proposals in response to a specific request for proposal are unique and therefore should not be compared to a single government generic cost estimate.

—It is not known where the proposed target cost number fits relative to a probability of success number; i.e., how optimistic or pessimistic is the proposed target cost? Likewise, it is not known how much overrun potential exists in the proposed program.

—It is not known where the government point estimate fits relative to a probability of success number.

Proposed Method

The first task is to define cost realism. There is no standard definition that fits all cases; therefore, one of the first tasks of RFP preparation should be the definition. The definition should convey to the offerors how cost realism would be measured by the SSEB (and scored if it is to be scored).

I believe cost realism can only be measured against a standard where cost estimates are developed on a risk

model. Furthermore, I propose that to make the process more effective, the offeror's proposal should be presented on a risk model rather than the current method which is only a point estimate without any knowledge of the point estimate's risk (probability of being exceed. d). Therefore, here are some recommendations.

—The request for proposal should require all cost proposals to be bid on a risk basis.

—The request for proposal should require that all cost proposals include a cost rationale section where the contractor can document (explain) why cost numbers are credible and reasonable, and schedule and program are credible and reasonable. The offeror should be required to identify in this section the program risk areas of the proposal and the risk-reduction plans.

—The request for proposal should require all major subcontractors to bid on a risk basis and that this proposal be made available to the Source Selection Evaluation Board.

—The SSEB should be required to develop its own cost estimate on a risk basis as described below for each proposal (there should be a cost realism standard developed for each proposal).

—The SSEB cost estimate mean and standard deviation and the contractor's bid should be displayed on a risk relationship (Bell) curve as described below.

How Is SSEB Estimate Developed On a Risk Basis?

Before commencing this cost estimation process, the Source Selection Evaluation Board, working through the contracting officer, must cause contractors to bring proposals in compliance with the RFP through traditional SSEB procedure (if the SSEB determines the proposal is not in compliance with the RFP or is unclear). Then, the first step in the cost-estimating process is one where the proposed schedule is adjusted by the SSEB for reasonableness (if it is judged to be unreasonable). Other areas may have to be adjusted if judged to be unlikely to occur in the fashion proposed. In addition, the SSEB must determine the schedule interrelationships that are impacted in the most pessimistic and most optimistic low-level estimates. Then a bottoms-up cost estimate is made on a risk model as described below. (There are other methods or models of developing the cost estimate on a risk basis.)
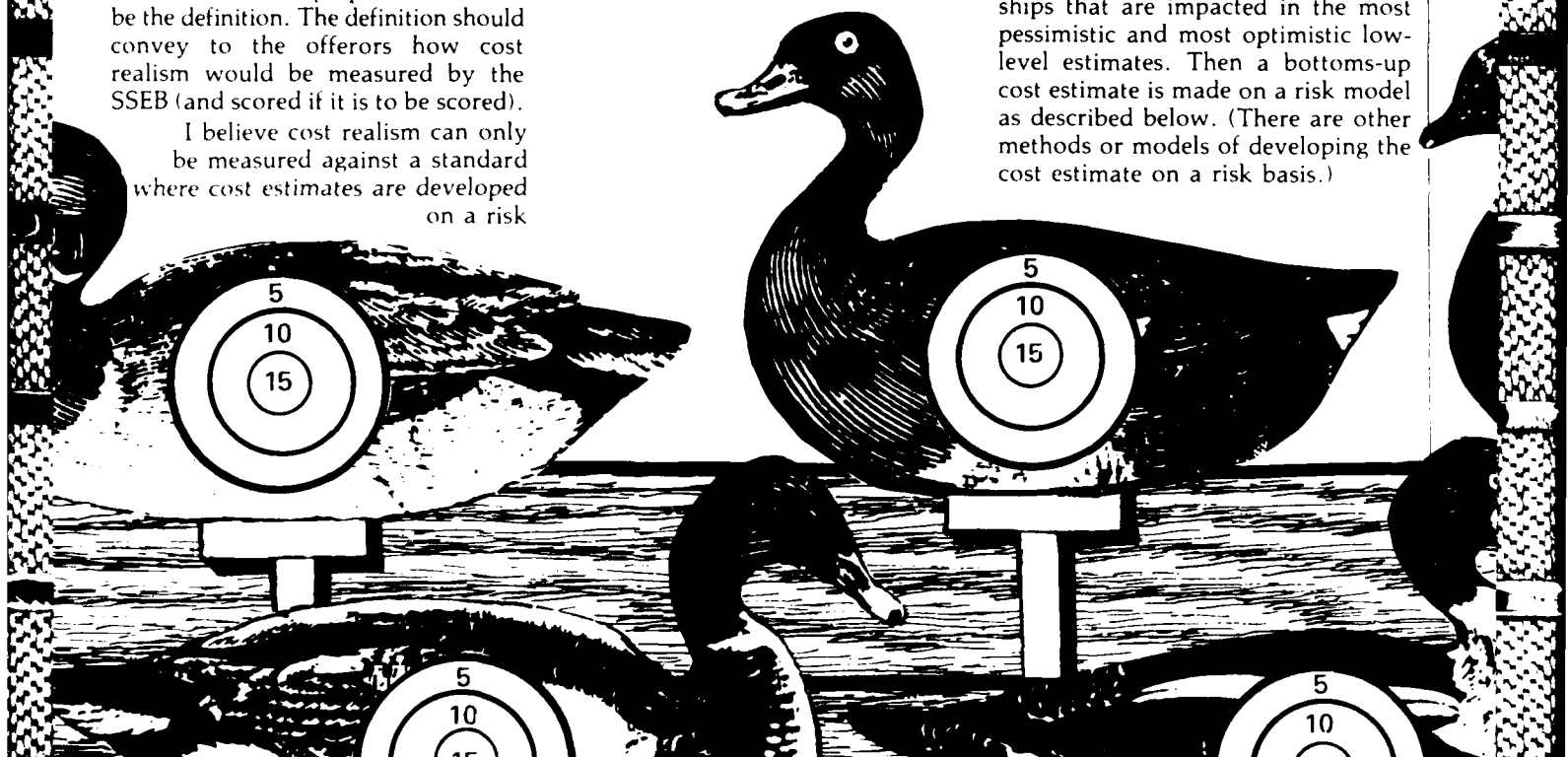
The procedure for the bottoms-up cost estimates performed by the Source Selection Evaluation Board requires that each cost element (labor hours, travel, manufacturing, materials, etc.) for each item of hardware or function be estimated three ways—most likely, most pessimistic, and most optimistic. Since these estimates are performed at low levels of the work breakdown structure (WBS) in the proposal, the statistical validity of the bottoms-up estimate is enhanced as the summation process evolves. Each low-level estimate may then be input to a computer program (usually a spreadsheet or data base management program) to obtain results at the total proposal level for the most likely, most pessimistic, and most optimistic point estimates (M, H, and L below).

Having the above three sets of estimates, a formula can be used to construct the "Bell-Shaped" cost relationship curve (see Figure 1).

The values of $\overline{X}$ and SD, the contractor's bid and the PMs budget are then put on a normal curve as described (see Figure 2 for example).

Application and Interpretation of Risk Relationship Curve (Figure 2)

The curve invokes the central limit theorem. It asserts that certain statistics, such as the arithmetic mean, tend to be normally distributed as the sample size becomes large. Thus, if samples are drawn from a population that is not normally distributed (skewed), the successive sample means will form a distribution that is approximately normal.

—The normal bell curve is used to reflect the mean ($\overline{X}$), standard deviation (SD) and make some statement relative to confidence of costs. For example, the mean plus or minus two standard deviations would express a 95 percent confidence *interval* that the cost value would fall between.

The normal curve may also be used to reflect a *not to exceed* statement (cumulative interval between zero and an X value) or to express the idea of *risk* to the right or left of a specific point on the X axis. For example, at the mean the relative value is 50 50. At plus 1 SD it is 84 16 (84 percent chance of not being exceeded or 16 percent

Let

H_i = most pessimistic low level estimate
M_i = most likely low level estimate
L_i = most optimistic low level estimate
H = total pessimistic point estimate
M = total most likely point estimate
L = total optimistic point estimate

Then the mean = $X = \dfrac{H + 4M + L}{6}$

Let the variance of each low level estimate = V_i

Then $V_i = \overline{H_i - L_i}^{\,2}$ for i = 1 to N where N = number of low level estimates in the summation to obtain total point estimate

Let V = the sum of all the V_i (i = 1 to N)

Then the Standard Deviation = SD = $\sqrt{V}$

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chance of being exceeded). At minus 1 SD is 16 84. For X values not falling on 1, 2, or 3 SD, area under the curve must be calculated. The formula $(X - \overline{X})$ divided by SD provides the number of standard deviations that X is from the mean. Then, this number is used in the standard statistical "look up" table to obtain the area to be added to (or subtracted from) 50 percent to obtain the risk of being exceeded.

In summary, any X value on the curve (cost estimate or contractor bid) can be defined as having a probability of being exceeded (number on right) or having a probability of being met (number on left). This, then, shows the risk of the program being accomplished at a given target cost (X value).

—Creating the curve (the cost numbers are only for illustration).

—SSEB mean obtained from the formula = $496M

—SSEB SD obtained from the formula = $44M

Horizontal scale is determined by plotting ± 1, 2, 3 SD values

SSEB point estimate (most likely) obtained from the cost estimate model = $436M (This is plotted to illustrate that it may be risky to use SSEB point estimates as a standard)

(All of the following percentage risks are calculated using formula and "look up" table)

—Percentage risk 5 05 on bid of $425M

—Percentage risk 8 02 on SSEB $436M point estimate

—Percentage risk 50 50 mean

—Percentage risk 00 1 on PME budget

—The Figure 2 curve represents an example of the SSEB risk model which will be utilized to measure cost realism. It includes the contractor's bid or target cost, the SSEB point estimate, the measure of central tendency or mean and the measure of dispersion or standard deviation. The mean and standard deviation could be the SSEB standard used to measure cost realism of the proposal. For illustration discussion and assignment of risk dollars the project manager's parametrical derived Project Manager's Estimate (PME) is overlayed. Management reserve may be established by capturing the difference between the bid or the signed contract and the PME point estimate or budget for the contract.

Strength of Proposed Method

After developing and displaying the cost estimate on a risk basis as above the SSEB then has the basis to measure three aspects of cost realism: a) the

SSEB
$\bar{X}$
496

SSEB
MOST LIKELY
POINT
ESTIMATE
436

CONTRACTORS
BID
425

CONTRACTORS
BID
425

50 | 50

5 | 95
8 | 92

99 | 1

| 364 -3SD | 408 -2SD | 452 -1SD | 496 | 540 +1SD | 584 +2SD | 628 +3SD |

AREA
.34 — .34
.4775 — .4775
.4985 — .4985
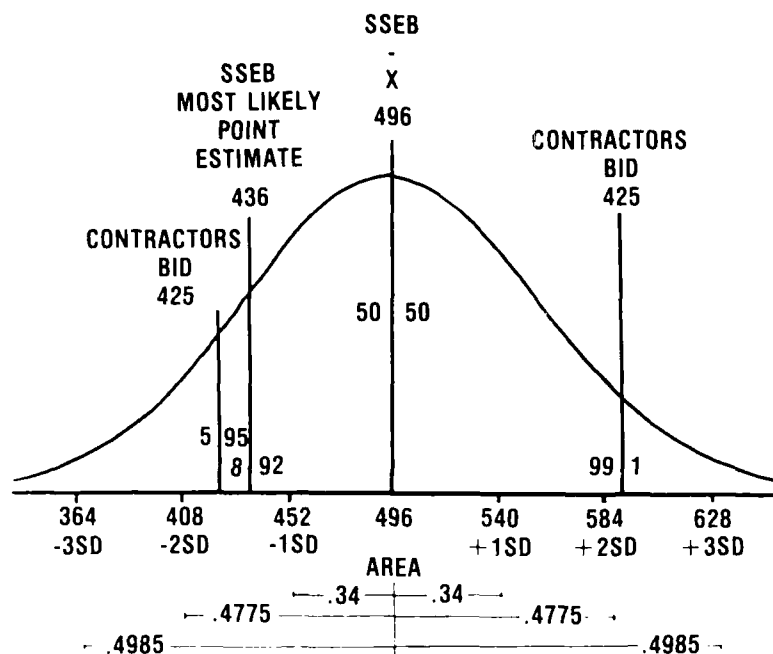
probability or risk of the contractor's bid being exceeded; b) the amount of over or under bid relative to SSEB mean (it is recommended that this point be the reference for measuring cost realism of the proposal); c) the value of standard deviation which provides the risk dollar exposure in contractor's bid. The general interpretation is that the further the contractor's

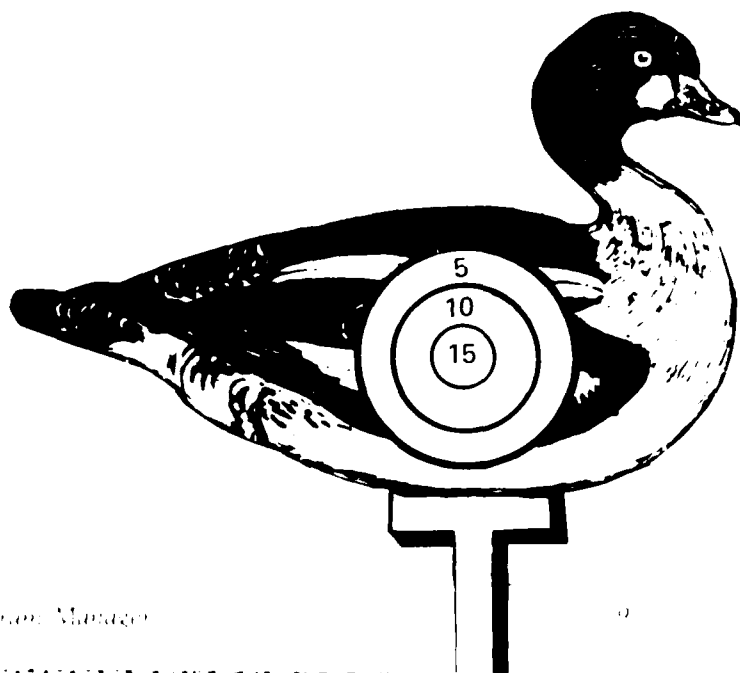Another benefit to this methodology is that now the proposed contract cost can be compared with the program manager's budget which would show how much of the contract risk is budgeted. (Note that before comparison, items in the program manager's budget not applicable to the contract award should be subtracted. Items like budget for future known and unknown contract modifications and budget for contract cost impacts due to future funding profile changes are examples as well as budget for other government agencies, other support contracts). Requiring contractors to propose on a risk estimate provides an additional two benefits. It forces the contractor to bid more realistically and it provides a better basis for the SSEB cost estimate being more accurate and, thus, a better standard against which to measure cost realism.

Summary

If the objective of emphasizing cost realism in the SSEB process is the ultimate objective of awarding a cost type contract at a reasonable target cost and with reasonable expectation of minimal overrun, then a change is required in the request for proposal and SSEB process. This change requires the SSEB cost reasonableness measurement process to be done on a cost-risk basis and to improve the overall process requires contractors to propose on a cost-risk basis with backup rationale which supports reasonableness and credibility of the cost proposal. This rationale must address credibility of the proposed approach and schedule for satisfying the request for proposal, and must be applied to all major subcontractors proposed by the Prime as a a part of the Prime's proposal. The major subcontractors should be required to bid to the Prime on a risk basis and these proposals submitted to the SSEB by the Prime as supporting data ∎

∎ Mr. Liston is Technical Director, ERIS Project Office, U.S. Army Strategic Defense Command, Huntsville, Ala.

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FINANCIAL

AND
CONTRACTOR
PRICING

Captain Kurtis J. McGrath, USMC
O. Douglas Moses

he business of acquiring major weapons systems for the Department of Defense is complex and expensive. The process takes place under intense scrutiny by the Congress, the media and the public. While familiar ties between the Department of Defense and defense contractors may exist, ultimately the Department of Defense seeks to reduce costs while contractors seek to ensure profits, and an inevitable difference of interests between the two exists. Each side pursues strategies during contract negotiation

and procurement in an attempt to achieve objectives. One aspect of a contractor's strategy is pricing: the pattern of prices charged for units procured over time. Do unit prices remain fairly stable? We felt a contractor's pricing strategy might be related to his financial condition and that documenting and discussing that relationship might be of value to contracting officers and program managers involved in the acquisition process.

Pricing Strategies

First, some background on pricing strategy. There are numerous ways to describe or categorize pricing strategies in general; but firms introducing new products or technology typically use one of two common product pricing approaches: penetration or skimming. Discussed by many authors,[2] the two strategies are widely understood and used by business practitioners. The skimming strategy calls for high initial prices followed by lower prices at later stages, while the penetration strategy calls for a low initial price with little or no price reduction over time.

The objective of the skimming strategy is to achieve the maximum profit in the shortest time by charging the highest price the market will bear. Price reductions occur in a series of steps timed to provide as much profit as possible at each step. Thus, the advantage of skimming is a more rapid return on investment. Firms adopting a skimming strategy must keep one step ahead of competitors: the risk is that competitors may underprice and enter the market.

In contrast, the objective of the penetration strategy is to develop wide product demand rapidly through a low initial price. Once the market has been captured, the firm can take advantage of either price increases or cost reductions to earn additional profits. The firm's established market position dampens incentives of competitors to enter the market.

Greer discussed the interest of buyers and sellers regarding pricing strategy. There are clear incentives for a seller to conceal pricing strategy. If competitors detect a skimming strategy, they may counter with a lower price and capture a market share. If competitors detect a penetration strategy, they will anticipate the risk of price reduction in the future

and be more encouraged to enter the market. There are economic benefits to be gained by a buyer detecting pricing strategy. Customers detecting a skimming strategy can delay purchases to obtain a more favorable price in the future. An "early" buyer of a new product would prefer to acquire from a penetrator while a "late-life" buyer would likely prefer to acquire from a skimmer.

Clearly defense acquisition, particularly for major weapons systems, is specialized in nature.[4] The products and the market are not typical of products and markets in general. Major weapons systems incorporate significant innovation with state-of-the-art hardware and substantial uncertainty in development. Products involving significant innovation offer the possibility of "learning" over time and provide the greatest leeway in choosing a pricing strategy.[5] The market for defense systems is unusual, with a single (monopsonistic) buyer and usually only a few (oligopolistic) sellers.[6] Yet, varying incentives exist for skimming and penetration within this market. Sellers that penetrate risk program termination before long-run profits can be realized. Sellers that skim risk program termination or curtailment due to excessive price, and risk competitor entry by encouraging the buyer to seek lower prices elsewhere. However, a large monopsonistic buyer, like the Department of Defense, may be in a position to thwart a skimmer's attempt at a high initial price by encouraging competition through second sourcing. Detection of a seller's strategy can potentially lead to significant cost savings for the informed buyer.

Our feeling is that pricing strategy may be influenced by financial condition, and that pricing strategy may be detected using financial ratios publicly available before product introduction.

Financial Condition and Pricing Strategy

Each of the two strategies can be described in terms of the relationship between two variables: the price of the first unit sold and the rate of price reduction over time. Skimmers exhibit a high first-unit price and a steep price reduction curve, while penetrators ex-

hibit a low first-unit price and a flat price-reduction curve. In principle, a seller could be indifferent to the two strategies. A high initial price coupled with steep price reduction, or a low initial price coupled with flatter price reduction could result in the same present value for a product and the same net economic benefit. Neither strategy is inherently more profitable. In practice, however, there are likely to be internal factors related to financial condition that may result in one or the other strategy being preferred.

Such factors may be reflected in the firm's financial ratios. Readers familiar with accounting or financial statement analysis are well aware that numerous ratios can be calculated from financial statement data, and that these ratios can be categorized in many ways. It is not unreasonable, however, to categorize financial ratios into five broad categories representing five aspects of financial condition:

—Profitability (return on investment)

—Short-term liquidity

—Solvency (capital structure)

—Activity (turnover)

—Capital investment.

Our object here is to suggest why pricing strategy may depend on these aspects of financial condition.

Profitability. As we indicated, neither skimming nor penetration is, in the long run, inherently more profitable; the central difference between the two is in the timing of profits. Skimming provides for high profit recognition immediately after product introduction; penetration offers the possibility of cost reductions or price increases and higher profits at a later stage. Since executives frequently are compensated on the basis of profit measures, one might expect concern regarding the effect of pricing strategy on such profitability measures. High profitability before introduction of a new product may be associated with continuing demand for high-profit projects in the short run. This is because low-profit projects may reduce the firm's overall average profitability. Penetration, when compared to skimming, increases the probability that average profitability measures will decline after product introduction. Such a decline is more likely for firms with high profitability before product
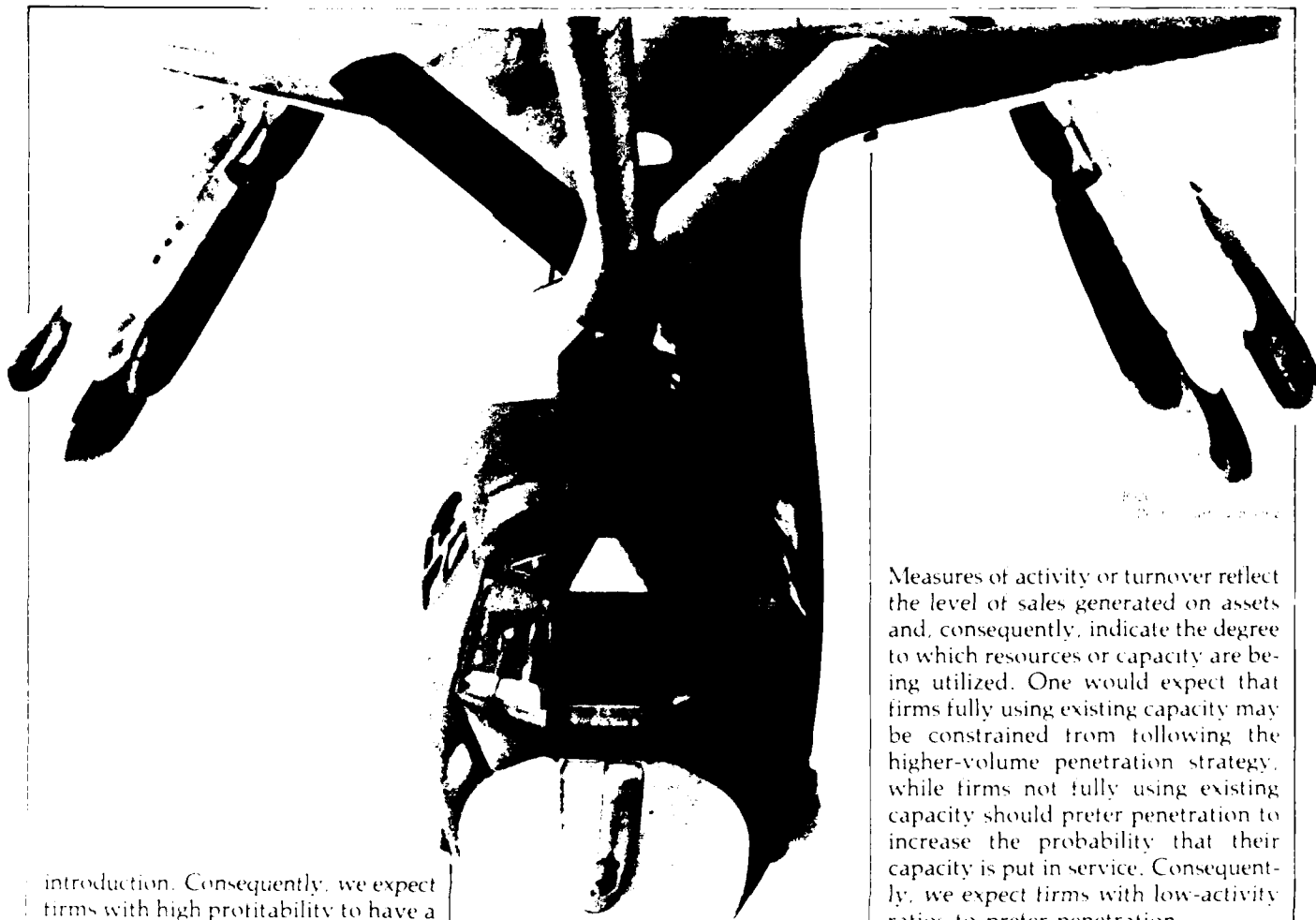
introduction. Consequently, we expect firms with high profitability to have a stronger preference for skimming.

Short-Term Liquidity. Initiation of new products may require substantial outlays to finance inventories, production volume, and product-introduction costs. Skimming, because of faster payback due to higher initial prices, is appropriate for firms needing funds in the short run.[7] Firms with a poor short-term liquidity position should have greater difficulty, or a higher cost of raising funds externally and may prefer to generate funds rapidly through the product. Consequently, we expect firms with poor liquidity to have a stronger preference for skimming.

Solvency. Solvency measures reflect the amount and type of debt in the firm's capital structure and indicate risk. Analogous to the reasoning presented above under liquidity, firms that are more highly leveraged should have a higher cost of raising new capital and may exhibit a preference for raising funds through the new project by skimming. In addition alternative pricing strategies differ with

respect to long-run risk. Penetration strategy requires that competition be discouraged, and that returns be earned over the long run to be successful. However, skimming, by front-ending profit, reduces the risk associated with future uncertainty in the product's market.[8] Firms with greater risk may prefer to reduce future uncertainty. For these reasons, we expect firms with poorer solvency measures (more debt) to prefer skimming.

Activity. If a firm has limited manufacturing capacity, a small volume but highly profitable market approach (i.e., skimming) may be the most economic.[9] Penetration requires wide diffusion of the product to be successful and consequently requires greater availability of resources or capacity to support greater volume

Measures of activity or turnover reflect the level of sales generated on assets and, consequently, indicate the degree to which resources or capacity are being utilized. One would expect that firms fully using existing capacity may be constrained from following the higher-volume penetration strategy, while firms not fully using existing capacity should prefer penetration to increase the probability that their capacity is put in service. Consequently, we expect firms with low-activity ratios to prefer penetration.

Capital Investment. Somewhat analogously, investment in new assets may indicate future pricing strategy. Skimmers should have less need to expand capacity, while penetrators, expecting to generate volume through low initial price, have a greater need to expand. Major investment in capacity could signal a penetration strategy and, given an increase in new assets, penetration would be preferable strategy to assure utilization of those assets. Consequently, we expect firms with high ratios of new investment in plant and equipment relative to existing assets or levels of activity, to prefer penetration.

To Summarize. We expect firms that skim, as compared to firms that penetrate, to exhibit measures of high profitability, poor liquidity, poor solvency, high-asset utilization, and low investment in capacity before new product introduction. In the following sections we provide evidence from an analysis of a sample of DOD contractors, that some of these expected relationships tend to exist.

Slope of Price Reduction Curve

As indicated, the two strategies can be described in terms of the relationship between first unit price and the subsequent price-reduction curve. Learning curves can be used to distinguish the two strategies. Learning curve theory[10] describes the decline in per unit production costs a manufacturer experiences with increasing volume. The learning-curve concept originated from the observation that individuals performing repetitive tasks tend to exhibit a rate of improvement, but there are many reasons for reduction of costs over repetitive operations: more efficient labor, less material from reduced scrap and waste, and higher productivity from improved processes. Thus, a learning curve more generally can be referred to as a cost-reduction curve. A per-unit reduction can be extended conceptually to the measure of price per unit. Thus, learning curves can be used to represent price-reduction curves.

The learning-curve function relates a dependent variable (price) with an independent variable (volume) as follows:

$$P = AX^B$$

or in log form:

$$\ln P = \ln A + B (\ln X)$$

Where P is the price of the Xth unit produced and A is the price of the first unit. If prices are level as volume (X) increases, then the exponent B is zero. B is negative when prices decline with volume. The slope of the learning curve, S, is related to B as follows:

$$B = \frac{\ln S}{\ln 2}$$

A slope of 1.00 implies a horizontal line, i.e., no price reduction. The lower the decimal value of the slope, the higher the price reduction rate. For example, .800 is a steeper (faster) price reduction rate than .900.

In our study we used slopes of learning curves fit to actual prices to reflect pricing strategy. Relatively high values for S are consistent with penetration (flat slope) while lower values are consistent with skimming (steeper reduction).

We examined price-reduction curves for major military weapons systems

F-86D	North American	51	.926
F-89D	Northrup	51	.885
F-86F	North American	51	.870
F-84F	Republic	51	.725
F-100A/C	North American	52	.839
F-1B/C/MF-1C	North American	52	.783
F-102-A	General Dynamics	53	.724
F-101-A/B/C	McDonnell Douglas	54	.802
F-100D	North American	54	.934
A-4B	McDonnell Douglas	55	.834
B-52G	Boeing	57	.869
F-106A/B	General Dynamics	57	.837
A-4C	McDonnell Douglas	57	.894
F-105B/D	Republic	57	.759
F-4A/B	McDonnell Douglas	59	.834
P-3A	Lockheed	60	.718
A-6A	Gruman	61	.829
RIM-24B	General Dynamics	61	.923
A-4E	McDonnell Douglas	61	.892
RIM-2E	General Dynamics	61	.930
F-4D	McDonnell Douglas	64	.886
A-7A/B	Vought	65	.852
P-3B	Lockheed	65	.910
RIM-66A	General Dynamics	66	.763
RIM-67A	General Dynamics	66	.825
AIM-7F	Raytheon	68	.773
A-7D	Vought	68	.950
S-3A	Lockheed	72	.846
F-15A	McDonnell Douglas	73	.917
AGM-78D	General Dynamics	73	1.088
AH-1S	Bell	75	.891
AH-1T	Bell	76	1.021
F/A-18A	McDonnell Douglas	79	.860
AIM-7M	Raytheon	80	.880
BGM-109	General Dynamics	80	.943

(aircraft and missiles) acquired by the Department of Defense from 1951-1980. Two publications, *U.S. Military Aircraft Cost Handbook* and *U.S. Military Missile Cost Handbook*,[11] provide a wealth of data on per-unit costs, volume and cost patterns for most major U.S. aircraft or missile systems. Price-reduction slopes using learning curves (constant dollars) are included.

Handbooks provide data for numerous weapon system programs which had to pass three filters to be included in the study. First, programs had to run at least 3 years in order to calculate meaningful slopes. Second, programs where learning curves fit to the raw price data provided a poor "fit" were eliminated. Since the purpose here is to explain variations in price-reduction curves, only programs with well-defined price-reducion slopes were included. An R^2 value in excess of .6 was used as a cutoff for program inclusion. Third, financial statement data for the year before program initiation had to be available without unreasonable search.

The remaining group consisted of 35 programs. Project identifiers, the manufacturer, the year of project initiation and price-reduction slopes for the 35 programs are provided in Table 1. Slopes around .800 to .900 are common for complex, high-technology products, although more extreme values are not rare, so the sample firms seem to be representative of the product type.

1. Return on Assets	Net Income/Total Assets	−	−.20
2. Return on Equity	Net Income/Stockholders Equity	−	−.27 •
3. Return on Capital	Net Income/Non-Curr. Liab + Stockholders Equity	−	−.22
4. Profit Margin	Net Income/Sales	−	−.13
5. Gross Margin	Gross Margin/Sales	−	.08
6. Current Ratio	Curr. Assets/Curr. Liab.	+	.25 •
7. Quick Ratio	(Cash + Mkt. Sec. + Acct. Rec.)/Curr. Liab.	+	−.03
8. Current Asset Ratio	Curr. Assets/Total Assets	+	−.16
9. Working Capital Ratio	(Curr. Assets-Curr. Liab.)/Total Assets	+	.12
10. Receivables Turnover	Sales/Accounts Receivable	+	.17
11. Debt Ratio	Total Liab./Total Assets	−	−.08
12. Equity to Debt	Stockholders Equity/Total Liabilities	+	.11
13. Curr. Debt Ratio	Curr. Liab./Total Assets	−	−.29 ••
14. Non-Curr. Debt Ratio	Non-Curr. Liab/Total Assets	−	.18
15. Interest Coverage	Operating Income/Interest Expense	+	−.04
16. Asset Turnover	Sales/Total Assets	−	−.23 •
17. Plant Asset Turnover	Sales/Plant Equipment	−	−.03
18. Inventory Turnover	*Cost of Goods Sold/Inventory*	−	−.05
19. Working Capital Turnover	Sales/(Curr. Assets-Curr. Liab)	−	−.19
20. Investment to Sales	Investment/Sales	+	.25
21. Invest to Funds	Investment/(Net Income + Depreciation)	+	.41 ••
22. Investment to Assets	Investment/Total Assets	+	.08
23. Investment to Plant	Investment/Plant & Equipment	+	.01

• Significant at ◄ .10
•• Significant at ◄ .05

Financial Ratios and Correlation Analysis

In general, our objective was to determine if financial ratios could explain variation in price reduction slopes in a manner consistent with previously stated relationships.

Twenty-three financial ratios [...] each of the five identified categories were computed for [...] for the year prior to pro[...]. Each ratio and its formula [...] in Table 2. In general [...] categories use associated to ones [...].

Each ratio was correlated with price reduction slopes. Expected signs (assuming ratios are related to pricing strategy in the way we anticipated) and correlations are reported in the right hand columns of Table 2. Several findings are interesting. In general, correlations are not extremely high and are not significant at traditional levels. However, one ratio within each category is significant and the signs of the correlations for those ratios are consistent with what we expected. The fact that there is one ratio in each category that is significantly associated with price reduction slope provides some initial indication that financial condition and pricing strategy are

related. In spite of the insignificance of the other ratios, all except five have signs as predicted. All ratios within the activity and investment categories have the expected sign. All five ratios with unexpected signs have low cor-

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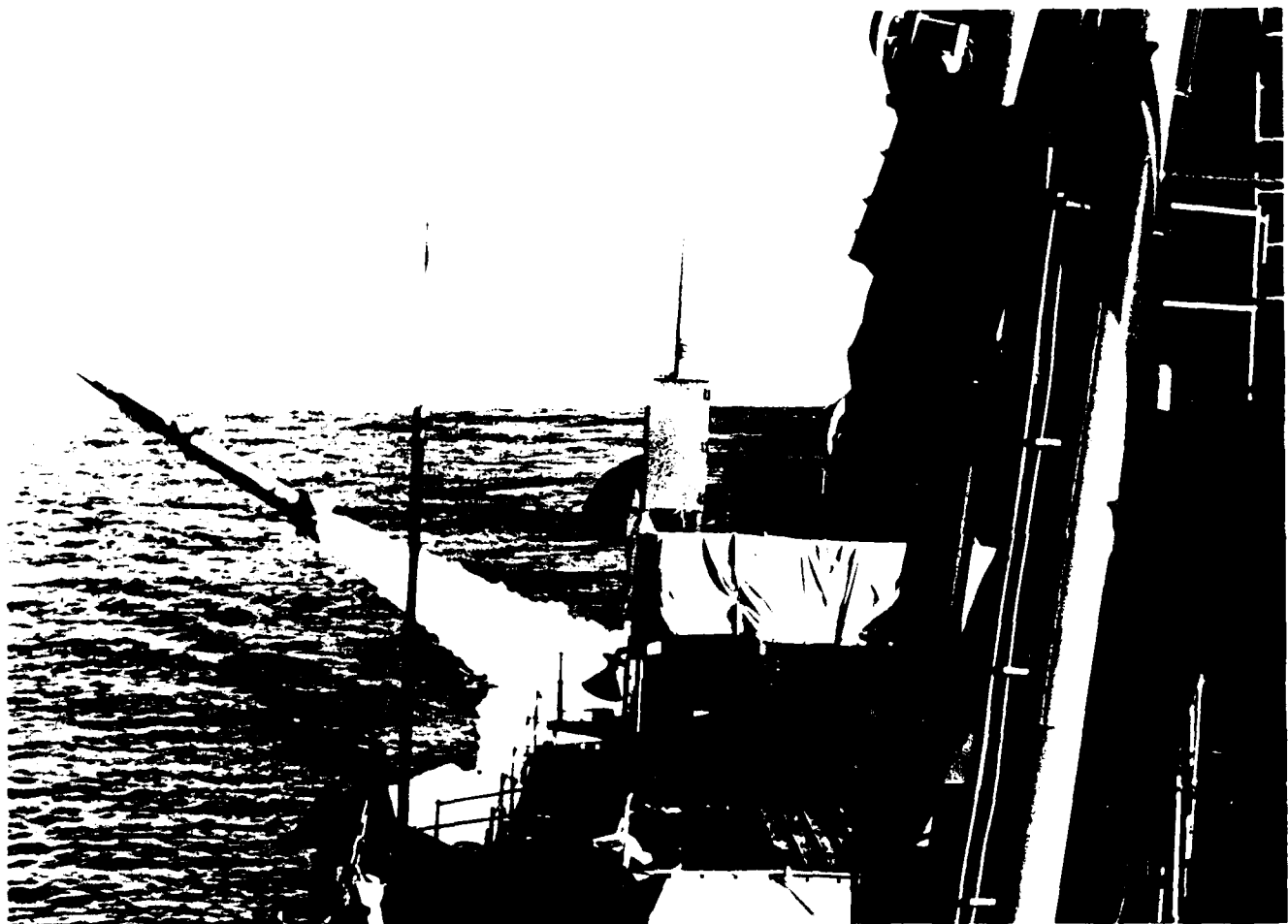
relations less than .2 while all ratios with relatively higher correlations (in excess of .2) have the expected sign.

Some of the unexpected signs are perhaps understandable. For example a negative correlation was expected for interest coverage. Yet negative signs are observed for both. One would expect, other things being equal, that firms with high profitability are more likely to have high interest coverage. Consequently, in our univariate correlation tests, the profitability aspect may dominate giving the negative sign for interest coverage.

This error indicates that univariate correlations are suggestive only, and that given the significant intercorrelation present in financial ratios, a multivariate model may be helpful.

A Multiple Ratio Model

We used stepwise regression to derive a model, including several ratios simultaneously. We started with a large set of variables, and the regression process selected one ratio at a time to add and one to delete.

ratio at a time to a model depending on which ratio most assists in explaining the variable of interest, in this case price-reduction slope. By selectively influencing the entry of variables into the model during the stepwise procedure a researcher has some control of the model that results.

We investigated various models in a heuristic and iterative fashion. We were concerned with three qualitative factors in constructing the model.

Parsimony. We preferred a model with few ratios.

Lack of interrelationship between ratios. High correlation between pairs of ratios in a model causes coefficients to be less meaningful and the model to be less useful for explanation or prediction.

Lack of redundancy. Some ratios in the study are just different measures of the same construct. For example return on total assets and return on equity are alternative return on investment ratios. We tried to use only one representative measure of each construct to avoid redundancy and excess detail in the model.

We considered three statistical items to determine when we had arrived at a "good" model:

The overall significance of the model (F values).

The significance of individual ratios in the model (t statistics for ratio coefficients).

The explanatory power of the model (adjusted R-squared values).

Table 3 provides detail on our best model. Looking at the table, several items are of note. The model is significant overall and has a reasonably high R^2 value. It explains more than half the variation among contractors in price-reduction rates. All six ratios in the model appear with the expected sign. Ratios from four of the five categories denoted earlier (Table 2) appear in the model, so it's fair to say that several important aspects of financial position are represented.

What Does Model Tell Us?

In general, the model demonstrates that pricing strategy is significantly associated with financial condition, and suggests that financial ratios available before manufacture and delivery of a new weapons system may be useful for detecting contractor pricing strategy. A relatively small collection of ratios appears to explain a fair amount of the variation in price-reduction rates.

The individual ratios in the model are interesting. As a group they tend to involve measures of current assets and current liabilities. The Current ratio compares liquid assets with near-maturing liabilities. The Receivable Turnover ratio reflects how rapidly accounts are collected. Both are tradi-tional indicators of liquidity. Solvency measures are designed to reflect the degree of debt in a firm's capital structure. The solvency ratio that proved most important here, the Current Debt ratio, emphasizes the firm's current liabilities only. The activity measure in the model, Inventory Turnover, relates sales volume to a current asset-inventory. Even the Investment of Funds ratio while designed to indicate the level of new investment in long-run capacity, may capture current aspects of operations; a high Investment to Funds ratio can mean a firm is generating relatively little cash flow from current operations relative to the amount of funds invested in new capacity. In short, each ratio can be seen as reflecting some current, rather than long-term, aspect of financial condition.[18]

$$\text{SLOPE} = .7745 + .0469\ (R1) + .0075\ (R2) - .3042\ (R3) + .0007\ (R4) - .0051\ (R5) + .1350\ (R6)$$

R1	+	CURRENT RATIO	LIQUIDITY	1.08	.15
R2	+	RECEIVABLE TURNOVER	LIQUIDITY	1.71	.05
R3	−	CURRENT DEBT RATIO	SOLVENCY	− 1.28	.11
R4	+	INTEREST COVERAGE	SOLVENCY	1.98	.03
R5	−	INVENTORY TURNOVER	ACTIVITY	- 1.11	.14
R6	+	INVESTMENT TO FUNDS	INVESTMENT	3.56	.001

F Value   :   5.29
Significance Level: .004
R^2 :   .665
Adjusted R^2 :   .539

Individual ratios in the model can be viewed in terms of broader concepts. The two liquidity ratios and the two solvency ratios collectively are indicators of risk. The activity and investment ratios are indicators of asset utilization. For these aspects of financial condition, the model supports our predictions: Firms with higher risk immediately before product introduction tended to prefer the skimming strategy. Firms that had significant new investment in assets, or were poorly utilizing existing assets before product introduction, tended to prefer penetration.

We did not find Profitability ratios to be significantly related to pricing strategy after controlling for ratios from the other categories. Given the nature of the sample (government contractors) this is, perhaps, not surprising. Interviews with major defense contractors[9] reveal that contractors tend to have the following goals:

- To reduce short-term risk from cyclic market activity through investment in diversified activities

- To employ properly financial and equity leverage

- To achieve operating effectiveness and efficiency

- To manage in an effective way the production, resources, and capital to achieve adequate return on investment.

Defense contractors have been characterized as risk adverse, profit satisfiers rather than profit maximizers.[20] The presence of risk and asset utilization measures in our model, and the absence of profitability ratios, are consistent with the goals and character of defense contractors.

Our objective has been to provide a discussion and evidence concerning the relationship between financial condition and contractor pricing strategy. Our purpose in presenting a model was to document and describe the nature of that relationship. Our findings suggest that measures of risk and asset utilization are factors influencing contractor pricing strategy.

We hope that contracting officers, program managers, or others involved in acquisitions activities may gain insight into the pricing practices of contractors from our analysis ■

Cited Footnotes

1   See "The Pricing Decision: Part 1 - The Cornerstone of the Marketing Plan," *Small Business Report*, Vol. 10, No. 5, May 1985, pp. 71-77.

2.   Two good treatments are Dean, J., "Pricing Pioneering Products," *Journal of Industrial Economics* (July 1969) pp. 180-187 and Wind, Y., *Product Policy: Concepts Methods and Strategy* (Addison-Wesley, 1982).

3.   Greer, W., "Early Detection of a Seller's Pricing Strategy," *Program Manager*, (Nov.-Dec. 1985). Pages 6-12 provide interesting study on relationship between pricing strategy and accounting methods.

4.   One might question the degree to which contractor has control of pricing strategy given the specialized nature of DOD contracting environment. At first glance there may seem to be little ability of contractors to exercise a pricing strategy if profit is negotiated and prices are ties to costs incurred. Prices may appear to be a direct function of costs with little leeway allowed for contractor pricing discretion. However, discretion is possible. The Cost Accounting Standards Board (CASB) specified procedures to guide the accounting for costs of goods produced for the government, but substantial flexibility exists within existing standards. Even if prices are tied to costs, the flexibility allowed in calculating costs permits flexibility in setting prices. Standards for dealing with the treatment of home office expenses, general and administrative expenses, service center costs, cost of materials and depreciable facilities and materials permit the contractor to choose among different, acceptable procedures or approaches in determining cost. The acceptable approaches permit flexibility in assigning costs to programs within a given period and in assigning costs across different periods. Allocation procedures are sufficiently subjective so that the cost of producing a product is the figure both parties agree to accept rather than true costs. Accounting procedures that assign costs to different periods, in particular, allow the recognition of costs earlier or later and consequently provide a contractor with the flexibility to cost-justify different pricing strategies. See Greer, W. and S. Liao, "Cost Analysis for Competitive Major Weapon System Pro-

curement: Further Refinement and Extension," Naval Postgraduate School Technical Report, NPS 54-84-023, Monterey, Calif., September 1984). Earlier recognition of costs would likely be associated with a higher first unit price and a steeper price-reduction curve. Delaying cost recognition would permit a lower first-unit price but result in a flatter price-reduction curve. Evidence from Greer, op cit., substantiates a relationship between accounting methods used by contractors and contractor pricing strategy.

5.   See Wasson, C., *Dynamic Competitive Strategy & Product Life Cycles*, (Challenge Books, 1974).

6.   For a discussion of the defense market see Olvey, L., Golden, J. and Kelly, R., *The Economics of National Defense*, (Avery Publishing Group Inc., 1984).

7.   The circumstances under which skimming and penetration are most appropriate are discussed in Dean, op cit. and James, B., "A Contemporary Approach to New Product Pricing," in B. Taylor and G. Wills, eds., *Pricing Strategy* (Staples Press LTD, 1969).

8.   Dean, op cit.

9.   James, op cit.

10   Many accounting texts provide a discussion of basic learning-curve theory, for example Kaplan, R., *Advanced Management Accounting* (Prentice-Hall 1982) pp. 97-105. See also Womer, N., "Learning Curves, Production Rate and Program Costs," *Management Science* (April 1979) pp. 312-319.

11   DePuy, S. et al, *U S Military Aircraft Cost Handbook*, TR-8203-1, (Management Consulting & Research Inc., 1983) and Crawford, D. et al, *U S Military Missile Cost Handbook*, TR-8203-3, (Management Consulting and Research Inc., 1984).

12   Greer, op cit, comments on this.

13   A few ratios require comment. Ratio 22, the Equity to Debt ratio was used rather than the more traditional Debt to Equity ratio because some sample firms had negative equity. For the Investment ratios 23-24, new investment in plant and equipment, P&E, was calculated as P&E, Depreciation and Amortization...

tailed Statement of Changes in Financial Position data was unavailable for many firms particularly those from earlier years. Each of the four investment ratios is an attempt to deflate investment for some aspect of firm size.

14. We used one-tailed tests of significance because our hypotheses specified a directional relationship between slopes and ratios.

15. Unadjusted R^2 always increases as more ratios are added to a model. A model can be found that statistically explains all variation in price-reduction slopes simply by including enough ratios. Adjusted R^2 is deflated to allow for the number of ratios in the model.

16. We found several candidates for best model. Models including only four or five ratios actually had higher F values and adjusted R^2 values almost as high as the six ratio model discussed in the paper. In addition, all ratio coefficients in the four and five ratio models were significant at .10 or better. However, the six ratio model has the highest adjusted R^2 and includes all of the ratios that were im-

portant variables in any of the other candidate models. It provides a better basis for discussion.

17. We conducted a factor analysis on the full set of ratios and, except for some overlap between the current ratio and the current debt ratio, each of the six ratios in the model is associated with a distinct individual dimension of financial condition.

18. However, models replacing the Current Debt ratio with the total Debt ratio and the Inventory Turnover ratio with the Asset Turnover ratio were still in excess of .40.

19. *Defense Financial and Investment Review*. (U.S. Department of Defense, June 1985).

20. See for example Kennedy, J., *Incentive Contracts and Cost Growth*, Report No. BRML-80-5103, (Air Force Business Research Center, Wright-Patterson AFB, October 31, 1983) and Kennedy, J., "The Appropriate Use of Incentive Contracts," *1985 Proceedings*. Federal Acquisition Symposium, Defense System Management College, Ft. Belvoir, Va., pp. 217-221.

The U.S. Army Materiel Command (AMC) Alexandria, Va. celebrated its 25th anniversary August 1, 1987. Established May 8, 1962, and activated the following August 1 in a sweeping reorganization of the Army, AMC became the first peacetime major field command of the Department of the Army responsible for developing and supplying materiel and logistics for the Army.

The AMC combined logistics functions of seven Army Technical Services in the assumption of weapons and equipment research and development acquisition and supply functions. These were the Quartermaster Ordnance Engineers Surgeon General Signal Chemical and Transportation Services some of which dated to the Revolutionary War and the early days of the Republic. General Frank S. Besson Jr. was the first commander of more than

21,000 military and 160,000 civilians whose mission was to improve the degree of excellence in research, maintain quality of thought and creativity, and apply these where needed.

Today's AMC is one of the largest and most complex commands in the Army, spending almost half of the total U.S. Army budget and employing more than 9,000 military and 113,000 civilians world-wide. Its mission is to support the soldier in the field by managing weapon systems and equipment from the initial concept development and fielding through its life cycle to final disposal.

During the year, the 389th Army Band AMC's Own will tour the country celebrating this silver anniversary and the Bicentennial of the U.S. Constitution. An anniversary exhibit will be shown in October at the annual Association of the United States Army convention, Washington, D.C. ■

An interesting Procurement Round Table report has been prepared by one of its directors, Professor Ralph C. Nash, Jr.

The report concludes that a totally new proprietary rights policy embodying five elements is necessary to provide the benefits of competition, while protecting the rights of contractors and greatly simplifying present regulations and contract clauses. The elements follow.

—Establish a single regulation for use by the Department of Defense and the civilian agencies.

—Separate the proprietary rights policies covering technical data from computer programs.

—Permit contractors to retain commercial rights in innovative work done on government contracts. At the same time, this policy must (1) permit the government to use all technical data developed on government contracts for internal purposes, and (2) require the contractor to license companies to use the data in government competitions.

—Pay contractors a royalty when they license competitors as compensation for the successful completion of a developmental effort.

—Avoid violating the proprietary rights of contractors by controlling the techniques used to obtain competition. ■

The Troop Support Command's Belvoir RD&E Center has awarded a $2,185,000 production contract for the Army's new Cleared Lane Marking System (CLAMS) which will help vehicle drivers follow safe paths cleared through minefields. Mounted on the rear of the lead minefield breaching vehicle, CLAM dispenses markers fitted with colored flags that can be seen easily during the day. Chemoluminescent lightsticks are provided for night operations. ■

THE SYSTEMS ACQUISITION PROCESS

*Lieutenant Colonel Robert M. Baker, USA*

uring the past 3 years the Army undertook a major effort to streamline its materiel acquisition system and procedures for developing and documenting materiel requirements. In this paper, I examine changes in the materiel requirements documentation system, and conclude these changes have a positive impact. Since problem areas remain, recommendations are made for further improvements.

One of the Department of Defense Acquisition Program Initiatives (Carlucci Initiatives) directed defense agencies to "reduce the number of DOD directives and eliminate our non-cost effective contract requirements."[1] This initiative was the Genesis of the Acquisition Streamlining Program; the Army has responded and totally revised material acquisition policies. These major changes were published in Army Regulation 70-1, System Acquisition Policy and Procedures, dated Nov. 12, 1986. This regulation makes tailoring of the traditional acquisition life-cycle model a standard procedure and introduces the Army Streamlined Acquisition Process (ASAP) the primary form of streamlining for low-risk developments. In conjunction with these efforts, General Richard H. Thompson, who was Commander of the U.S. Army Materiel Command, established "a goal for all developmental programs not to exceed four years-- that is four years from a Milestone 1 program go-ahead decision (with *funds in place)to start of production."* He said the "four year developmental goal is the heart of a larger overall effort to reduce the entire systems acquisition process from the traditional 11-15 years to 7-9 years."[4]

Therefore, considerable attention has been given to requirements documents supporting the materiel acquisition process. These documents are the foundation for any materiel development: without an appropriate requirements document a developmental effort cannot begin. Quality and timeliness of requirements documents are vital to any effort to shorten the acquisition process. In the past, the cumbersome system for developing and staffing requirements documents often resulted in documents which did not adequately describe the requested development or included requirements

MATERIAL REQUIREMENTS DOCUMENTS

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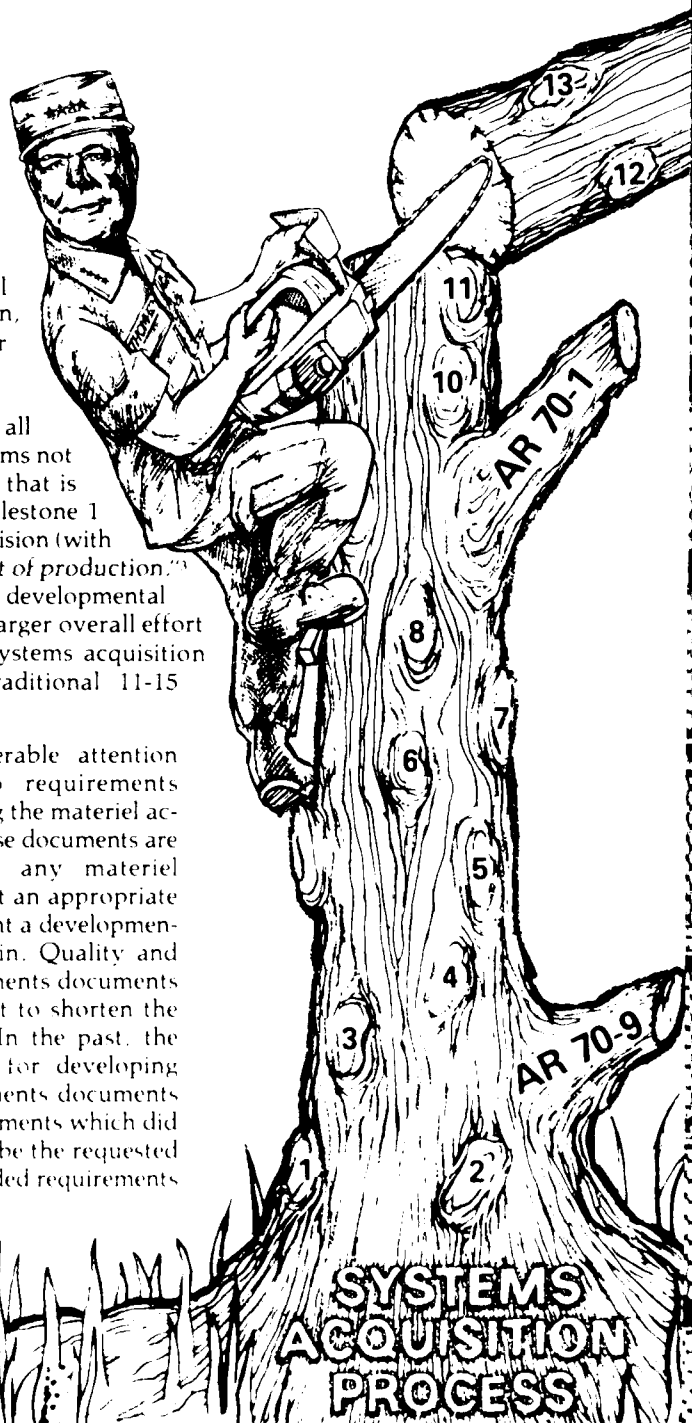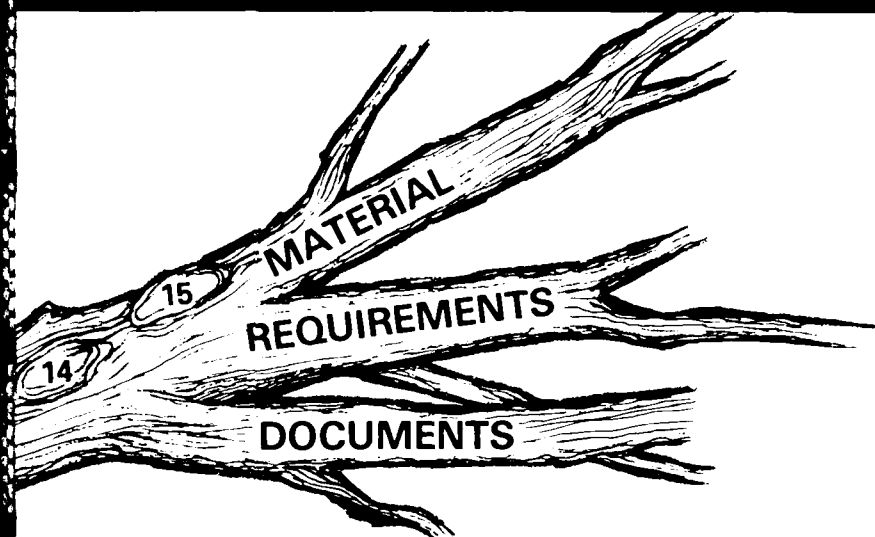
which were in a nice-to-have category or demanded high-risk technology. Without a reduction in the processing and approval time for requirements documents, it is unlikely that the acquisition cycle's length can be reduced by 4 years.

In addition, there are imperatives which make increasing efficiency of the requirements process very important.

First, as the required time increases for the document to be written and approved, technology may change thereby increasing the chance of technological obsolescence of the development, and decreasing the probability of defeating the threat.

Second, the process length discourages industry and decreases its commitment to direct independent research and development (IR&D) funds to the project.

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Third, the lagging process of document approval may make the requirement more difficult to defend in securing funds from the Office of the Secretary of Defense and the Congress.

Fourth, the needed system is unnecessarily delayed.

Finally, there is a great waste of manpower resources in the staffing and restaffing process which could be more gainfully employed.[5] These facts and the need to meet time goals of streamlined acquisition dictated an overhaul of the Army materiel requirements process.

My purpose here is to look at the Army materiel requirements process as it existed until early 1986, to examine reasons for changing the process, to look at changes adopted and, finally, to assess progress in implementing changes to the system. The changes adopted are more than cosmetic; they are substantive and, when fully implemented, should have a major impact on the research and development and procurement portions of the Army budget, and on the quality of equipment provided to U.S. soldiers for the next 20 years.

ARMY SERVICE BOARD OF 1983

Because of the broad scope of the requirements process, this paper concerns primarily the materiel requirements documents, and statting and approval procedures for these documents; in these areas, quality and timeliness of the documents are most affected. To present a manageable topic herein, training device requirements documents will not be considered. Because changes in the requirements process are far-reaching, it is important that new procedures be assessed early in the implementation so that necessary changes can be made before problem areas develop.

System Before Revision

The Army materiel acquisition process is structured and designed to coordinate efforts of agencies to field an operational capability in the shortest time. Responsibilities are generally split between the combat developer and the materiel developer. The combat developer, usually the U.S. Army Training and Doctrine Command (TRADOC), is responsible for formulation of doctrine, concepts, organizations, materiel requirements and objectives. It represents the user community in the materiel acquisition process. The materiel developer, usually the U.S. Army Materiel Command, is responsible for research, development, and production of a system in response to approved requirements. We see by these definitions that the major player in the development of requirements is TRADOC but, in reality, establishment of a requirement is a joint effort of TRADOC and AMC from concept initiation through approval of the last change, to the last requirements document for a system.

The basis for development of materiel requirements is the concept based requirements system (CBRS) which is the process by which doctrine, training, organization and materiel deficiencies are identified and corrected through the analysis, development and application of operational concepts. The CBRS responsibility of the combat developer, starts by developing an umbrella concept of how the Army will fight in the future by analyzing missions and requirements in context with projected threats and technological forecast.

After developing the broad umbrella concept, functional proponents (i.e. Infantry School, Engineer School, and

Armor School) develop operational concepts describing how each service branch will perform its mission within that concept. These functional concepts form the basis for each branch mission area analysis (MAA) which is an analytical effort describing the capability of that branch to execute its approved concept as a member of the combined arms team within the umbrella concept. From this analytical effort, deficiencies are identified and are
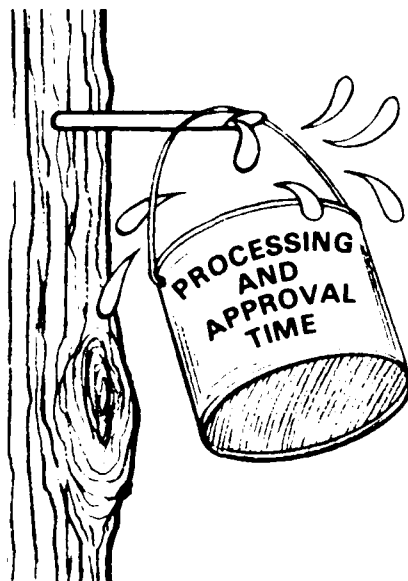
analyzed to determine if they can be corrected by developing new doctrine, training, organizations, materiel or any combination thereof. Solutions favor doctrine, then training, then organizations and, finally, materiel development. This decision hierarchy ensures the most economical solution.

After each proponent establishes and prioritizes deficiencies they are forwarded to TRADOC to be merged into an Army-wide prioritized list of deficiencies, the battlefield development plan (BDP). The BDP, capstone document for the MAA process, provides the basis to focus, schedule and integrate TRADOC efforts in support of current and future Army missions. Before early 1986, these prioritized deficiencies were one of the primary generators of science and technology objectives which, until March 1986, provided priority and structure for funding and effort in the technology base.

As mentioned, a materiel development is the least-favored solution to an MAA deficiency. Even if a materiel solution is chosen, a product improvement to an existing system or acquisition of an off-the-shelf non-developmental item (NDI) must be considered before deciding on a new development program.

Using the materiel requirements process, which existed until late March 1986, the decision to initiate a new system started a mind-boggling documentation process. First, for all systems, an operational and organizational (O&O) plan was required and was the program initiation document used to state the purpose of the system: where, how and by what organization it would be used; and how it would fit into the overall force. It authorized fund expenditures for the concept evaluation phase of the life-cycle system management model (LCSMM), phases of which are shown on the traditional process chart at Figure 1. The O&O Plan was to contain ten or fewer pages, was approved by the Commander, TRADOC, and was provided to Headquarters, Department of the Army (HQDA) for information.

If the system was determined to be DOD major (costs greater than $200 million for research, development, test and evaluation or greater than $1 billion in procurement), a justification for major system new start (JMSNS) was required. The JMSNS is a three-page document which must be submitted to the Department of Defense to obtain approval to start a major system; if approved by the Secretary of Defense, it is promulgated to the Army in the program decision memorandum (PDM) issued by the Office of the Secretary of Defense in response to that year's Army program objective memorandum. The PDM is the authority for program initiation and expenditure of funds for the concept exploration phase of the life-cycle system management model.

The Letter of Agreement is the requirements document required to support the demonstration and validation phase of LCSMM. It was approved by joint agreement of the TRADOC Commander and the AMC Commander if the Advanced Development category of research, development, test and evaluation funds was expected to exceed $25 million. If the expected funding did exceed $25 million, the

document had to be approved by the Army Deputy Chief of Staff for Operations and Plans. There was no limit on pages but it was to be kept to a minimum.[5]

The required operational capability document supported the full-scale development phase of the LCSMM, was to be four pages in length and approved by Headquarters, Department of the Army. The document's six major annexes except for the coordination annex were removed before forwarding to Headquarters, Department of the Army for approval.

The letter requirement was a document for low-value items whose RDTE costs did not exceed $6 million per year, or procurement costs, $12 million per year; and total costs, RDTE plus procurement did not exceed $50 million for the 5-year program. This single document served the demonstration and validation and full-scale development phases of the LCSMM for low-value items. The TRADOC Commander and the AMC Commander could jointly approve this document whose goal was four pages. Moreover, similar documents existed for training devices and joint requirements and special documents existed for other categories like the experimental 9th Motorized Infantry Division and Special Operations Forces.

The many types of requirements documents had confusing and separate procedural rules, approval authorities and size goals. Using the old system, a major system required as a minimum an O&O Plan, a JMSNS, an LOA, and a ROC — each with separate supporting documents and annexes.

Initial writing of the requirements document was not a major problem. The problem involved the staffing process each document had to follow on its way to approval. Staffing procedures are prescribed by Pamphlet 70-2, DARCOM/TRADOC Materiel Acquisition Handbook. The U.S. Army Development and Readiness Command (DARCOM — a previous name for AMC). Although each document had different staffing procedures, this section will describe the procedural staffing of an LOA as an example of some of the problems.

After the letter of agreement was written, or the proponent school or agency

Armor, Artillery, Signal. The author was usually an Army captain or civilian of equivalent grade. It was sent to the Joint Working Group (JWG) on a worldwide basis for review before the first JWG meeting, of which membership varied but usually included TRADOC Headquarters, TRADOC schools, TRADOC Integrating Centers (Combined Arms, Logistics and Soldier Support), AMC; the AMC proponent Major Subordinate Command, Headquarters Department of the Army; test agencies; and interested major army commands (MACOMs). After incorporation of staffing comments, joint working group and action officers rewrote the document based on agreements and staffed the revised letter of agreement with the Joint Working Group.

Based on comments, a coordinated draft letter of agreement was written. Often, a second JWG meeting was required to concur on major revisions; the coordinated draft LOA was forwarded simultaneously through TRADOC integrating centers to TRADOC, MACOMs, and other services, and through the proponent major subordinate command to AMC — all with comments for TRADOC Headquarters. There, the action officer from the Office of the Deputy Chief of Staff for Combat Developments, TRADOC, staffed the document internally and based on external and internal staffing prepared a final draft LOA with the JWG chairman, which was presented to the TRADOC requirements review committee. Next, the TRADOC action officer again revised the document and sent it to the TRADOC commander for approval before forwarding to AMC Headquarters for staffing and authentication. After authentication by the AMC Commander, the LOA was published by TRADOC Headquarters. If advanced development costs did not exceed $25 million. If 6.3 costs were more than $25 million, the LOA was forwarded to Headquarters, Department of the Army for staffing and approval by the DCSOPS. Once approved, the document was returned to TRADOC for publication.

In the view of Army senior leadership, this process is unnecessarily complicated. Furthermore, at any step higher headquarters could return the document to the proponent school for a rewrite. That any documents were

ever approved is a tribute to the tenacity of action officers. Yet, it was possible for a development with a very-high-level interest to skip most staffing steps and be approved rapidly. Documents produced in this manner, however, often required revision after approval, —sometimes at a high cost. Although time goals were provided (6 months for an LOA), it was apparent they could not be met and were not tracked. Goals became meaningless. Based on a sampling of 20 requirements documents in 1984, TRADOC estimated formulation and coordination of a requirements document took 20-50 months.[9]

After completion, documents often were not high quality. Much can be attributed to the process length, inexperienced personnel as authors, and the personnel turnover in TRADOC combat development positions.

Efforts to Improve the System

It is apparent that the Army materiel requirements documentation system is complicated and time consuming, a fact evident to people working with the system. No serious change came until efforts were initiated to shorten the materiel acquisition process in response to the Carlucci Initiatives. After assuming command of TRADOC, General William R. Richardson made revision of the requirements process priority. He sensed Army frustration with the system and saw the solution as a way of shortening the acquisition cycle.[10] He began an effort to study the system in the spring of 1983 which resulted in a study by the Army Science Board in December 1983. Concurrently, senior officials at AMC (then DARCOM) began efforts to shorten the acquisition cycle and recognized the impact requirements documents had on the system. The Commander, General Donald R. Keith, and the Deputy Commander for Research and Development, Lieutenant General Robert J. Moore, advocated streamlining the documents. Major AMC impetus began when General Richard H. Thompson assumed command in June 1984. His desire to cut 4 years from the acquisition cycle resulted in the initiation of major changes to acquisition regulations which would often require mandated changes in regulations and procedures concerning requirements documents.

Encouragement was provided by James R. Ambrose, Undersecretary of the Army, who felt TRADOC should lead in developing the revisions,[13] and by General Maxwell R. Thurman, Army Vice Chief of Staff, who fully understood the need for reducing the staffing time for requirements documents.[14]

In September 1984, the Army Science Board *Report of the Panel on Processing Requirements Documents Study* was published. This report, hereafter referred to as the Trainor Study, written by Dr. Richard J. Trainor, found 19 specific weaknesses in Army procedures for processing requirements documents. Dr. Trainor recommended resolutions. The Trainor Study was the first published comprehensive analysis of the problems with the requirements process. Although many of the resolutions were not adopted, the study was received positively by the senior Army leadership and served as a major input to the subsequent efforts to revise the process. In October 1984, General Richardson directed his staff to propose changes to Army Regulation 71-9, *Materiel Objectives and Requirements.*[15] Concurrently, General Thompson directed his staff to accomplish a major rewrite of Army Regulation 70-1, *Systems Acquisition Policy and Procedures.*

The TRADOC Headquarters and AMC Headquarters saw the need to ensure regulations were coordinated, and they communicated this concern to Headquarters, Department of the Army, which was the approval authority. In February 1985, Major General John W. Woodmansee, Jr., Army Assistant Deputy Chief of Staff for Operations and Plans, Force Development, directed his staff to develop a concept to examine the entire materiel acquisition process to ensure all efforts were coordinated and that new revisions met Army needs. After discussions in the spring of 1985 on the proper forum, it was decided in early June that a 2-3 week study be conducted by a panel of colonel-level representatives of HQDA, TRADOC, AMC, and other agencies. Results would coordinate Army efforts and provide the basis for a subsequent 6-9 month task force representing the Army, OSD, congressional staffs, and industry. During the 2 week study, all

materiel acquisition regulations were discussed and the need for changes determined. It was decided that Army Regulations 70-1 and 71-9 would be concentrated on, with all supporting regulations to be integrated with the two and published as soon as possible. The 2-week meeting established a consensus on problems with the Army requirements system and established the basis for further rewrite of Army Regulation 71-9. Specific problem areas with the requirements process noted by the study group were as follows:[16]

—Initial requirements in the documents are too rigid and therefore cannot be met. They need to be written as broad bands of performance.

—Requirements documents guidance is too general and permits too much discretionary variation. On the other hand, the documents are generally too specific and are hardware-oriented rather than performance-oriented.

—Policies on writing and staffing documents are too vague.

—Requirements are allowed to creep during development, making it difficult for contractors and expensive for the government.

—There are too many outdated requirements still active in the system which have not been funded.

—There is no capability to track documents during the staffing and approval process.

—There are too many proponents without an effective honest broker.

—Performance characteristics are often overstated resulting in "gold plated" systems.

—MACOMs do not respond during coordination of requirements documents.

—Cost and schedule drivers are not addressed during document development.

—There is need for more senior officer involvement in the early stages of requirements definition.

—Too much supporting documentation is required for requirements documents.

—Duplicative requirements exist.

—Approval of documents by HQDA takes too long.

—Approval authority is centralized at a level too high in the Army. Authority needs to be decentralized.

—There is too much betting on unproven technology.

—There is no quick, simple process to document low-cost, low-risk developments.

—The entire process of documentation is too complicated and time-consuming.

Many weaknesses noted by the Trainor Study were noted as major problem areas by the Army study group. With the foregoing guidance and full support of senior Army leadership, as evidenced by the following statement by General Thurman in the fall of 1985, TRADOC began its final rewrite of Army Regulation 71-9.

In order to work well with industry we must know enough to give them good direction, and we must be confident in demanding that our standards be met. We must drive the requirements process in revolutionary ways. Our requirements statements must be simple and complete and include the soldier. This is not impossible.[17]

In February 1986, a final joint working group preceded a general officer consensus meeting on March 7, 1986, wherein the revised Army Regulation 71-9 was approved with minor changes. The regulation was forwarded to key agencies March 27, 1986, for implementation in draft form pending final publication. The regulation has completed final staffing and is in the final edit process prior to publication.

Results of the Reform Process

Concurrent with issuing the draft for implementation, TRADOC Headquarters issued a letter of instruction (LOI) "Combat Developments Tailoring Process - Management of Requirements Documents," and shortly thereafter a standing operating procedure (SOP) "Management of Requirements Documents Within HQ TRADOC." These two documents are interim guidance for procedures to be utilized in developing and staffing requirements documents using the new AR 71-9 pending final revision and publication of the revised AMC-TRADOC Pamphlet 70-2 scheduled for 1987. Because the scope of this

paper is limited primarily to requirements documents, the final draft of AR 71-9 and the LOI and SOP on processing requirements documents have been used as the basis for reporting results of the reform process.
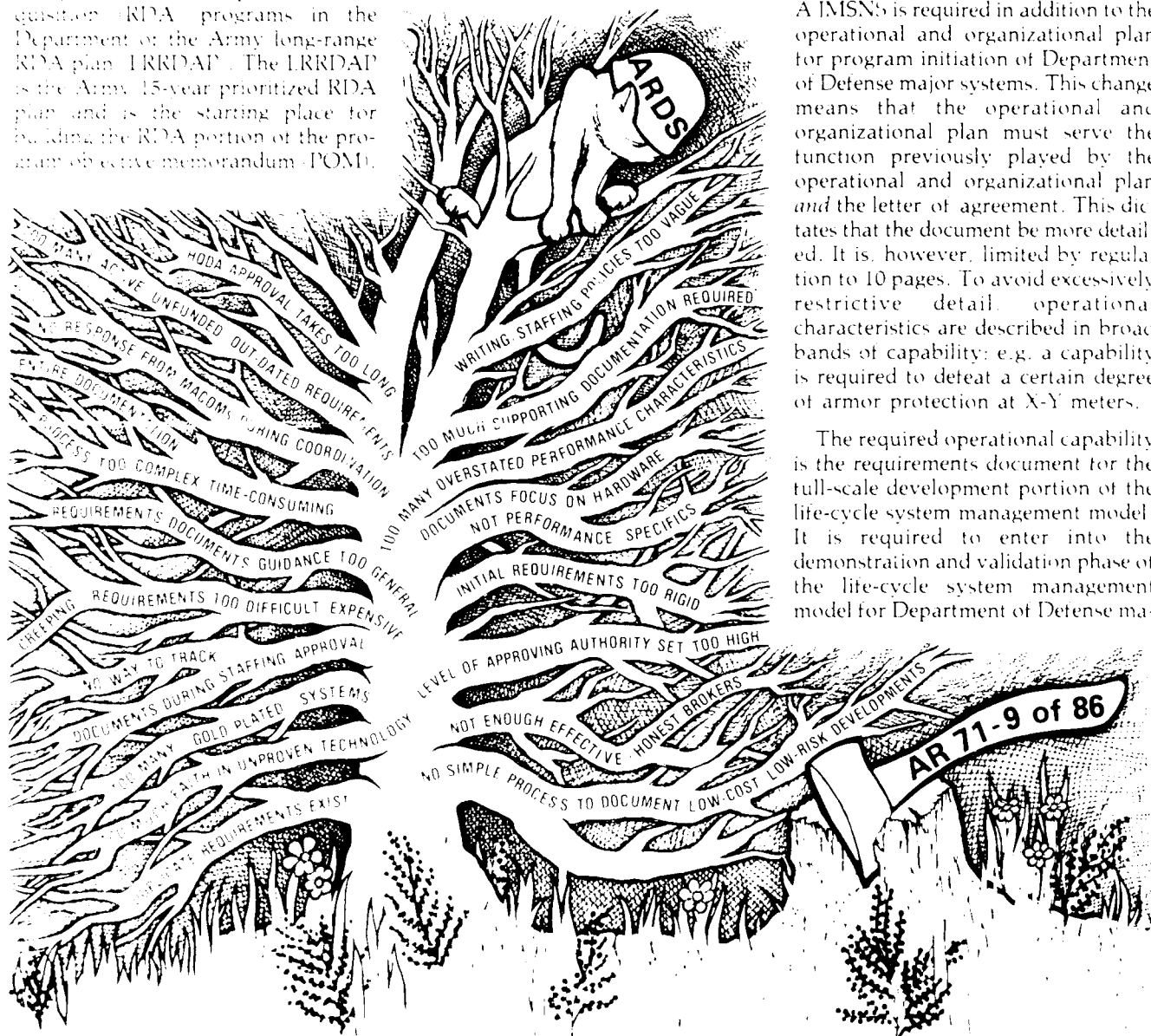
One key change in the new AR 71-9 is formalization of the battlefield development plan (BDP) as primary driver of the efforts of the technology base. Previously considered a TRADOC document, the BDP now provides the basis for prioritization of Army research development and acquisition (RDA) programs in the Department of the Army long-range RDA plan (LRRDAP). The LRRDAP is the Army 15-year prioritized RDA plan and is the starting place for building the RDA portion of the program objective memorandum (POM).

The new regulation recognizes the streamlined acquisition initiatives in AR 70-1 and the fact that tailoring of the life-cycle system management model (LCSMM) is now the norm rather than the exception. A chart showing the streamlined process compared to the traditional process is at Figure 2. In order to meet time lines of streamlining initiatives, the LOI provides a goal that the required operational capability be approved within 2 years after the initiation of the operational and organizational plan. The

new regulation eliminates the letter requirement and letter of agreement leaving the operational and organizational plan and the required operational capability as the only requirements documents needed for a normal system acquisition. This change simplifies the process.

The new operational and organizational plan is the only requirement for the advanced development (6.3) category of funding for all systems except DOD major systems and HQDA designated acquisition programs. A JMSNS is required in addition to the operational and organizational plan for program initiation of Department of Defense major systems. This change means that the operational and organizational plan must serve the function previously played by the operational and organizational plan *and* the letter of agreement. This dictates that the document be more detailed. It is, however, limited by regulation to 10 pages. To avoid excessively restrictive detail, operational characteristics are described in broad bands of capability; e.g. a capability is required to defeat a certain degree of armor protection at X-Y meters.

The required operational capability is the requirements document for the full-scale development portion of the life-cycle system management model. It is required to enter into the demonstration and validation phase of the life-cycle system management model for Department of Defense ma-

Top chart

MILESTONE	PROGRAM INITIATION	◇ I	◇ II	◇ III	
PHASE	CONTINUING ANALYSIS OF MISSION AREAS	CONCEPT EXPLORATION	DEMONSTRATION & VALIDATION	FULL SCALE DEVELOPMENT	PRODUCTION & DEPLOYMENT
	BASIC RESEARCH | EXPLORATORY DEVELOPMENT				
DECISION REVIEW	TISC I	TISC II / JRMB ASARC I IPR	JRMB ASARC II IPR	JRMB ASARC III IPR	
DECISION DOCUMENT		SCP	DCP	DCP	
BASIC SUPPORTING DOCUMENT	LRRDA PLAN / JMSNS O&O PLAN		ROC		
PROGRAM CATEGORY	6.1 / 6.2 / 6.3A	6.3B		6.4 / LLT	PROCUREMENT
TESTING		MARKET INVESTIGATION	IT / OT	IT / OT	PRODUCTION TEST / FOE
	FOTE AS NEEDED				
HARDWARE CONFIGURATION	BREADBOARD & EXPERIMENTAL PROTOTYPES		BRASSBOARD & ADVANCED DEVELOPMENT PROTOTYPES	ENGINEERING DEVELOPMENT PROTOTYPES	INITIAL PRODUCTION ITEMS / FINAL PRODUCTION ITEMS

Bottom chart

MILESTONE	PROGRAM INITIATION	◇ I/II	◇ III	
PHASE	RQMTS & TECH BASE | PROOF OF PRINCIPLE	DEVELOPMENT PROVEOUT	PRODUCTION & DEPLOYMENT	
DECISION OUTCOME	START	NDI/DEVELOPMENT	TC LP / TC STD	TC STD
BASIC SUPPORTING DOCUMENT	JMSNS O&O PLAN / ROC			
PROGRAM CATEGORY	6.1 & 6.2 / 6.3	6.4		PROCUREMENT
TESTING	MARKET INVESTIGATION	TT / OT	PRODUCTION VALIDATION TEST	LLT / PRODUCTION TEST / FOT&B
	FOTE			
HARDWARE CONFIGURATION	SURROGATE BRASSBOARD ADVANCED DEVELOPMENT PROTOTYPES	DEVELOPMENT PROTOTYPES HARDTOOLED PROTOTYPES	PREPRODUCTION OR LIMITED PRODUCTION ITEMS	INITIAL PRODUCTION ITEMS / FINAL PRODUCTION ITEMS
EVALUATION				

for systems and Headquarters Department of the Army designated acquisition programs. Provisions are made for the fact that information normally will not be available for a full required operational capability at that point; it is recognized that the required operational capability must be updated and approved by Headquarters Department of the Army before entry into full-scale development. The new regulation permits tailoring of required analysis to meet new time lines which are goals not requirements established in the LOI—26 weeks for an operational and organizational plan, and 36 weeks for a required operational capability.

The revised regulation establishes a new document, Operational Needs Statement (ONS), providing an opportunity for commands and agencies outside the combat and materiel development communities to initiate the combat development process by stating a user's operational need for a materiel solution to correct a deficiency or improve a capability which impacts upon mission accomplishment. Although not a requirements document, it will often lead to one.

Capstone requirements documents are recognized and encouraged by the revised regulation. These operational and organizational plans and required operational capabilities are prepared for families of materiel to encourage using the same or similar major components such as common chassis for a family of vehicles.

Using the new staffing letter of instruction, procedures for document staffing are shortened and streamlined and are characterized by front-end work and one-time formal staffing. The document is prepared by the proponent school and fully staffed internally. Following that front-end work, it is distributed for comments and concurrence in a one-time formal staffing to TRADOC Headquarters, TRADOC integrating centers, TRADOC schools, AMC Headquarters, AMC Major Subordinate Commands and primary MACOM. A response is mandatory. The document is distributed to other MACOMS, HQDA staff agencies, Military Traffic Management Command, U.S. Army Logistics Evaluation Agency, other services and appropriate allied nations.

After this one-time formal staffing a joint working group meets and attempts are made to accommodate comments and disputes. The document is revised based on the joint working group and forwarded from the school commandant to AMC Headquarters and to TRADOC Headquarters through integrating centers for approval. The document is reviewed by the TRADOC RRC. The RRC must include representation from the proponent school, AMC Headquarters, and the AMC proponent major subordinate command. After the RRC comments are incorporated by the TRADOC DCSCD action officer, it minor; or by the proponent school if major. The document is forwarded to the proper level for approval.

The change in approval authority is one major improvement of the new requirements process. Whereas LOAs formerly had to be approved by Headquarters, Department of the Army, for all programs with systems advanced development costs exceeding $25 million, now all operational and organizational plans, which replace the letter of agreement for most systems, can be approved by the TRADOC Commander. Department of Defense major systems require a justification for major system new start to be approved by the Secretary of Defense. The ROCs for programs costing less than $100 million in RDTE and/or $500 million in procurement may be approved by the joint signature of the TRADOC Commander, and the AMC Commander. This approval level includes most systems and will shorten the approval process. The ROCs more than the $100 million and $500 million limits must be approved by Headquarters, Department of the Army.

Another major improvement in the materiel requirements document process is establishment of the materiel development program review established by the April 10, 1986 SOP and promulgated to TRADOC schools by message. It requires that each proponent school brief the DCSCD, TRADOC, on a quarterly basis about the status of developmental programs during the review, programs are given a status rating of green, amber, or red by managerial decision. If a program falls behind its projected time line because of documentation it may be rated amber or red. The TRADOC Headquarters records these projects in

an automated system called the Materiel Development Automated Milestone System where problem systems can be tracked for intensive management.

The above changes present the possibility of improvement in the materiel requirements document process. If they are effective, major process time savings should be realized, and TRADOC should be able to divert many man-hours to other activities.

Effectiveness of System Reforms

Because reforms are in a draft stage and implementation began in late March 1986, findings of this assessment of system reforms are preliminary. In order to accomplish the assessment, I interviewed personnel at Headquarters, Department of the Army; Headquarters, Training and Doctrine Command; Headquarters, Army Materiel Command; U.S. Army Combined Arms Center; U.S. Army Infantry School; U.S. Army Engineer School; and U.S. Army Air Defense Artillery School. Initially, an attempt was made to get hard data on whether projects were meeting the newly established time goals. Because there were so many exceptional cases and so few projects actually started since introduction of the new system became effective, this course of action was abandoned as impractical. Findings, therefore, are not only preliminary but subjective. Note that schools and integrating centers other than those interviewed may have had different experiences. In spite of these shortcomings, many items of interest arose which should be useful for making the new system work.

On the positive side:

The increased approval authority at levels below HQDA is seen as a major gain. It meets the user's need by getting documents approved more quickly and efficiently.

It serves to clear the logjam of documents at the overworked Army Staff. Because of the one deep staffing on the Army Staff, the problem of moving many documents for quick approval was unsolvable. Now the staff can concentrate on fewer and more important systems.

Second, the streamlined process provides better control over the number and quality of new re-

quirements. Because the school commandant must personally approve all documents before forwarding, he will be more aware of them and more likely to act to ensure quality documents are produced and marginal requirements are eliminated.

The quarterly materiel development program review, perceived as a positive measure at all levels, introduces discipline into the system and provides pressure to ensure schedules are on track. Even if the review is time consuming for the proponent, the schools believe it is worthwhile. When the materiel development automated milestone system is fully automated and provides a direct modem access to outside agencies, data gather by the reviews will be more usable.

Staffing time is being cut. Front-end staffing time at the schools is being reduced. Previously documents went through multiple do loops of writing, staffing, IWGs, and rewriting before being forwarded for approval. The one-time staffing has cut that drastically.

On the negative side:

The TRADOC letter of instruction which provides procedures for developing and processing requirements documents is not universally accepted as an authoritative document outside TRADOC.

Procedures have been set up to accelerate the basic document but not the accompanying and supporting documents such as the basis of issue plan, qualitative and quantitative personnel requirements information, test design plan, cost and operational effectiveness analysis, integrated logistical support plan, reliability, availability and maintainability rationale annex, manpower and personnel integration requirements, etc. Many of these are controlled by other regulations under revision. It will take a Herculean effort to make them all support the new time frames, AR 70-1 and the staffing guides governing AR 71-9. Note that the materiel development automated milestone system is being set up to register time lines for some of this documentation but will be inadequate unless changes in basic regulations ...

... Combat Developments Staff ... operated the ... total of combat develop ...

... time required for them to become proficient but experience and grade levels do not match AMC counterparts. Based on projected reductions in officer strength and tight civilian manpower restrictions, this situation probably won't improve.

Time line goals have been set up but are probably not achievable without extraordinary management, particularly the requirement to have an approved required operational capability 2 years after operational and organizational plan initiation. Based on the early look at requirements documents, times are being shortened but the 26-36-week goals for operational and organizational plans and required operational capabilities are not likely to be met. The 2-year goal for the required operational capability depends on completion of testing and the subsequent independent evaluation report, and on supporting documentation being provided in time. This is unlikely.

Initial joint working groups using the new system have not worked well. It has been difficult to get substantive comments before the IWG, and representatives attending often did not have *authority to commit their commands* to the IWG position. As a result, documents have been returned with extensive comments after the proponent school forwarded the document for approval. The IWGs have often been chaired by junior military officers not having extensive experience in materiel acquisition.

Elimination of the letter of agreement requires more detail in the operational and organizational plan. Schools find it difficult to get detail early in the development. The requirement to provide test issues and criteria with the operational and organization plan is difficult because the system has not been defined. Providing issues and criteria helps define the system but they may have to be changed before early testing.

Procedures for tracking requirements documents are not fully developed. The materiel development automated milestone system is not fully interactive to provide direct access to users outside TRADOC. Headquarters. The TRADOC is however developing that capability.

... operational capability for a major system or designated acquisition program to enter demonstration and validation was added with ... guidance on required operational capability preparation. The ... guidance was to state that at this point in the life cycle the parameters will of necessity be broad. This should be more explicit. The many TRADOC schools may interpret this guidance differently, resulting in a lack of uniformity in the final product.

Coordination of the requirements document with industry is not being accomplished. This is supposed to be accomplished during the one-time formal staffing process. This shortcoming exists in spite of the fact that a joint TRADOC-AMC letter of instruction requiring staffing with industry was published in March 1986.

A final observation outside the scope of this paper concerns the AMC goal of a 4-year development. Some schools note that AMC is unwilling to take any risk in development and is trying to force all developments into the Army streamlined acquisition program. This program is for low-risk development only and relies on using pre-planned product improvement to increase capabilities. Although certainly not a problem with all AMC subordinate commands, some seem to resist requirements the schools believe are needed now in order to avoid going into a medium- or higher-risk development.

Recommendations

The following recommendations should be viewed in the context that revisions to the process are in their infancy. There are bound to be problems, particularly since implementation has occurred before publication of final regulations and pamphlets. In spite of this, review of the process is healthy. Revisions, clarifications, and redirections can make the new process more effective. In that spirit I would recommend that:

Senior personnel in TRADOC, AMC, and other commands place increased emphasis on following the new staffing procedures during the crucial implementation phase.

All commands and agencies properly review and provide comments on ...

CUTS IN STAFFING TIME

EARLY SENIOR LEVEL REVIEW

QUARTERLY MATERIAL DEVELOPMENT PROGRAM REVIEW

AR 70-1
AR 70-9

...als of streamlined acquisition and ... tailored combat developments process.

If after reviewing supporting regulations it is determined that key documents like the BOIP QQPRI TSP and HR cannot meet the 4-year Army Materiel Command development goal and the 2-year goal to produce a required operational capability goals should be revised. Supporting documentation is too important to ignore.

Efforts be continued to reduce personnel turbulence in TRADOC Combat development positions and to ensure well qualified personnel fill positions.

All TRADOC schools ensure that requirements documents are staffed with industry as required by the TRADOC AMC letter of instruction. This may eliminate unrealistic requirements and direct industry use of independent research and development funds.

Definitive guidance be place either in AR 70-9 or AMC TRADOC Pamphlet 70-2 on preparing the initial required operational capability for Department of Defense major systems and designated acquisition program.

The AMC investigate to determine whether the 4-year developmental goal and directives to use low risk development with pre-planned product improvement are being perceived as an absolute requirement which is inhibiting AMC subordinate commands from pursuing higher risk development needed for legitimate user re...

The TRADOC assess early implementation of the new regulations in the training community to ensure that problems in implementing the new regulations regarding training devices are detected and corrected.

Steps taken by Headquarters Department of the Army TRADOC and AMC to improve requirements documents procedures have had an overall positive effect. All known problem areas were addressed. Success of the reform will depend on aggressive leadership in the early stages of implementation to ensure that new procedures are not ignored. If the mentioned shortcomings are not addressed reforms will be viewed as a failed process and returning to business as usual will be the tendency. It is crucial that new regulations be published promptly along with those supporting documentation also that leaders ensure procedures are followed. Only through these efforts will the tremendous potential of changes be realized. ∎

Cited References

1. Status Report on Acquisition Streamlining, *Program Manager*, July-August 1985, p 21

2. U.S. Department of the Army, System Acquisition Policy and Procedures, AR 70-1, Washington, D.C., 12 November 1986, para 7-3b

3. General Richard H. Thompson, AMC CG Discusses Key Concerns, *Army Research Development and Acquisition Magazine*, November-December 1984, p 18

4. General Richard H. Thompson, Army Materiel Command Streamlining Acquisition, *Program Manager*, May-June 1985, p 18
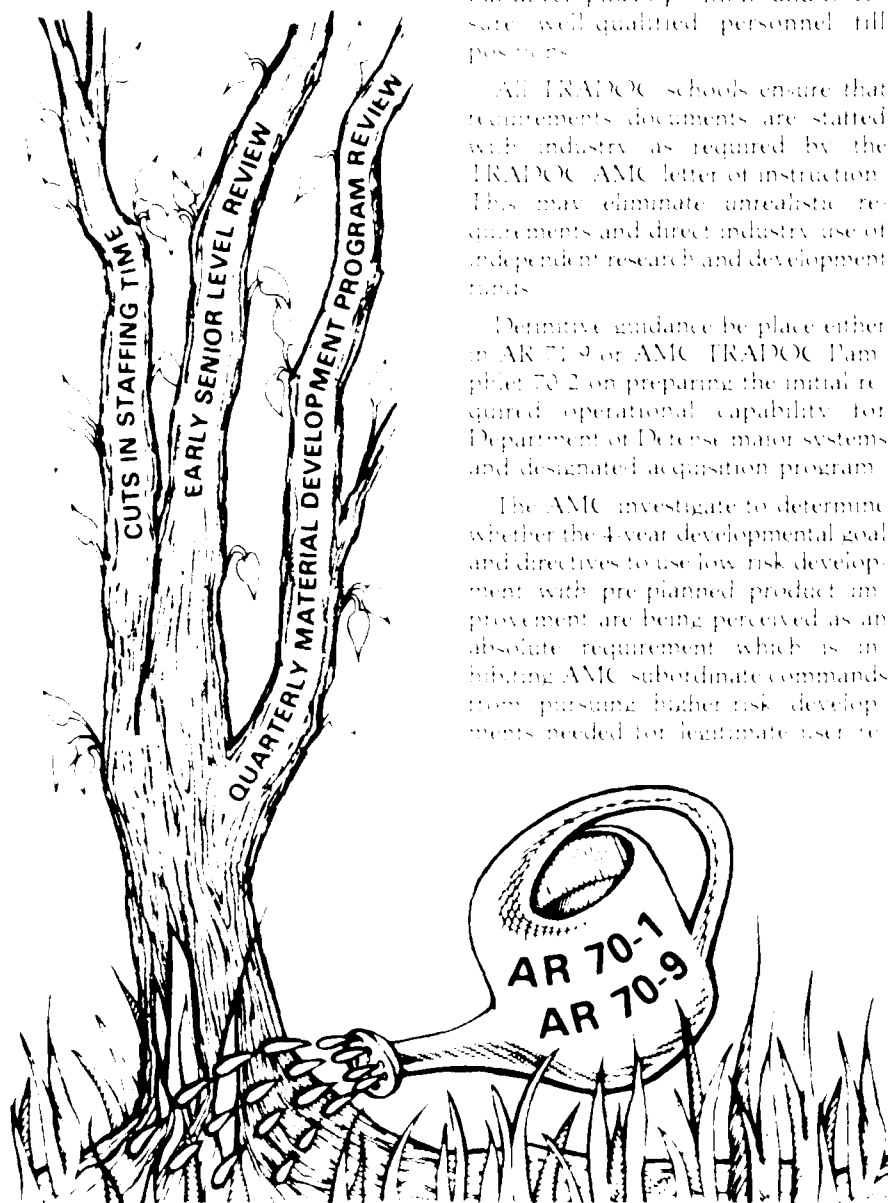
7. Ibid. p. 36

8. Ibid. para. 6-8a

9. Army Science Board p. 2

10. Hartman, Darell B. U.S. Army Office of the Deputy Chief of Staff for Operations and Plans Interview. 31 October 1986.

11. Atlanta Seminar Focuses on New Acquisition Initiatives. *Army Research, Development and Acquisition Magazine* May-June 1982. p. 5.

12. Interview with LTG Robert L. Moore, DCG for RD&A. *Army Research, Development and Acquisition Magazine* January-February 1984. p. 20.

13. Gen. William R. Richardson. Discussions with Mr. Ambrose on the Requirements Process. Memorandum. USATRADOC. Ft. Monroe, Va. 8 October 1984.

14. Exclusive Interview: Gen. Maxwell R. Thurman Army Vice Chief of Staff. *Army Research, Development and Acquisition Magazine* November-December 1984. p. 2.

15. Richardson Memorandum.

16. Meeting notes on Colonel-level Study Group on Materiel Acquisition Process. ODCSOPS HQDA. 6 July 1985.

17. Gen. Maxwell R. Thurman. The Promise of the Future. *Army* October 1985. p. 57.

18. Lieutenant Colonel Frederick J. Cossairt III. Final Version of AR 71-9. Information Memorandum. Memorandum. HQDA. DAMO-FDR. Washington, DC. 23 December 1986.

... al Development Labor ... Management of Requirements ... Letter of Instruction ... USATRADOC. Ft. Monroe, Va. 25 ...

The Army's 15, 30 and 60KW generators have been retrofitted with a new and improved governor adapted for military use by the Troop Support Command Belvoir RD&E Center. It is more reliable, easier to maintain, less expensive and lighter in weight than the electro-hydraulic system previously used.

Tests showed that the new governor will run an average of 8,592 hours between failures compared to 3,887 hours for the electro-hydraulic unit. On the average, the new governor weighs 83 percent less. Engineers estimate the new governor will save the Army nearly $1 million during the next 5 years. Nearly 2,400 generators already in the Army inventory were retrofitted; new generators will be equipped with the governor when built. ■

The U.S. Army saved more than $370,000 as a result of a value engineering proposal submitted by a Fort Ritchie, Md., employee. James D. McGuire, communications specialist, Office of the Deputy Chief of Staff for Plans and Operations for the 7th Signal Command, headquartered at Fort Ritchie, recommended that as part of the continental United States telephone modernization program, two telephone upgrades be combined.

Mr. McGuire's value engineering proposal suggested the Fort Baker, Calif. upgrade be combined with the Presidio of San Francisco upgrade ...

The Army Troop Support Command's Belvoir R&D Center will be surveying electrical power requirements of Army equipment systems under field conditions using a specially designed mobile instrumentation van.

...

UNRAVELING
THE
PRODUCTIVITY

Eric E. Anschutz

here is a national consensus that productivity improvement is an important issue for the coming decade. United States industry must improve output and quality to continue a leading force in world commerce. For people in government the requirement to improve performance is urgent to minimize the tax burden and to provide productivity leadership.

Productivity Measurement

One challenging requirement of productivity improvement programs is to design methods for measurement of productivity changes. The challenge is particularly difficult when the activity whose productivity is being measured produces intangible support rather than a tangible product or a measurable service. Such activities hereinafter called support activities include most administrative and engineering organizations. Though support activities produce tangible entities like reports, drawings and memoranda, it often is difficult to quantify changes to productivity because of fluctuation in type and complexity of such organizations' work.

In an attempt to measure support activities' productivity, measurements are sometimes made of micro indications of performance including for example, the number of reports or invoices, timeliness of delivery, man hours per document and amount of rework required. The weighted sum of such indicators yields some notion of productivity, but is at best, an imprecise way to take into account all the factors [unclear] quality of out put and variation in workload etc etc. What we need are indicators [unclear]

[remaining left column text illegible]

that while the system proposed herein is designed to measure customer satisfaction, it is in reality measuring the activity's performance against separate tasks that the activity must accomplish. A student's report card is a simple analogy. It measures student performance, not teacher satisfaction. Customers and teachers are brought into the evaluation process because they are, at least for some tasks, best qualified to evaluate performance. To be sure, there will be tasks where performance is a matter of record and customer evaluation is not needed. For students the attendance record is in

this category. For commercial activities profit/loss is such a parameter; for public sector activities adherence to budget and/or manpower limits are facts of record needing no customer evaluation. Indeed, by structuring a number of performance parameters in ways that make them subject to information of record, e.g., ratio of programs under cost to programs over cost, customer satisfaction can, without undue complication of the process, be one of a mix of productivity performance indicators.
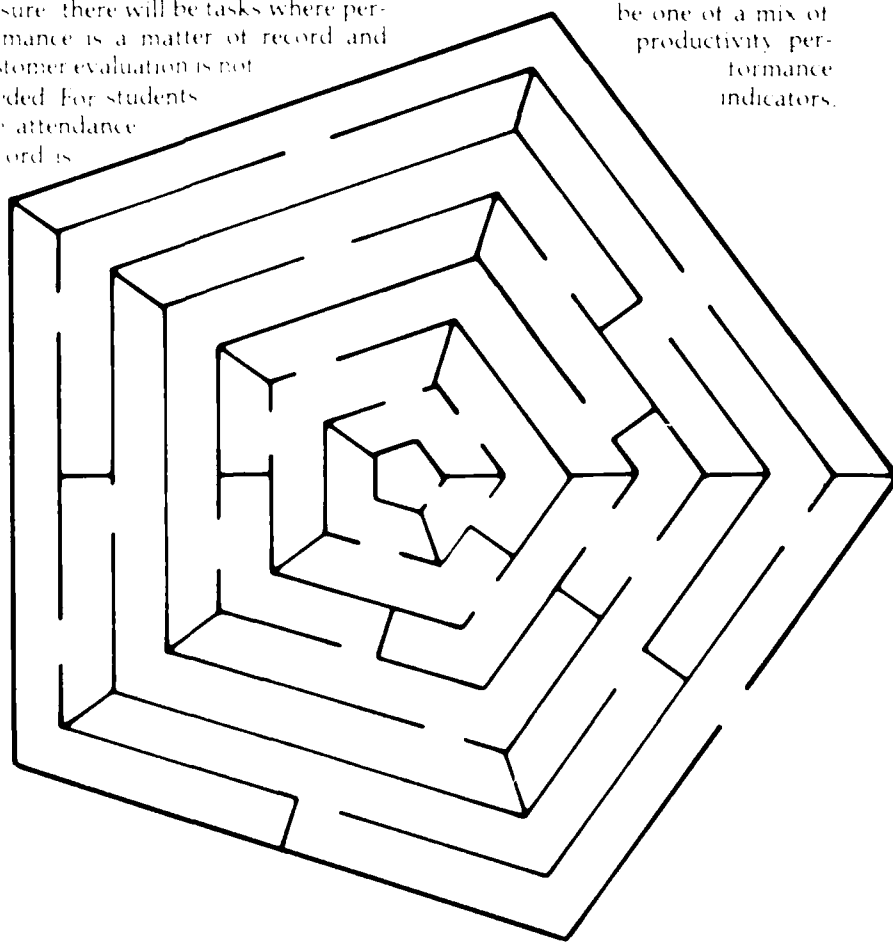
The customer satisfaction productivity measurement system proposed here begins with the generally accepted premise that each organizatinal unit exists to support or serve customer(s). A second premise is that performance is the same (for our purpose) as productivity; a third premise: performance improvement has economic value and can be quantified monetarily; a fourth premise: customer satisfaction can be measured with relative objectivity; a fifth premise: a measurement of customer satisfaction is the integral of all other performance measurements. Building on these, I propose a measurement system for consideration.

The performing organizational unit enters into an informal agreement with customer(s) about the service it provides. Where possible, the performance contract should contain performance standards, preferably but not necessarily quantitative, against which performance can subsequently be evaluated.

Based on the performance contract, a customer report card (a sponsor satisfaction index) is negotiated between performing organizational unit and customer(s). The report card might include items like timeliness, quality, and adherence to budget. More subjective factors like cooperativeness and responsiveness could be included.

Annually (or more frequently) the customer(s) will rate performance of performing organizational unit using agreed sponsor satisfaction index format. Frequent reporting (quarterly) affords constant motivation and better real-time control, but is more demanding to administer.

The baseline rating will be determined either by agreement between the performing unit and its customer(s) or, alternatively, by the first rating. For example, if the rating criteria are 1-5, with 5 as excellent and 1 as unacceptable, it may be agreed that a 3 shall [illegible] above average [illegible] the baseline for year 1.

Performance improvement [illegible] any given performance year [illegible] between the rates for the base year and the rating for the performance year. [illegible]

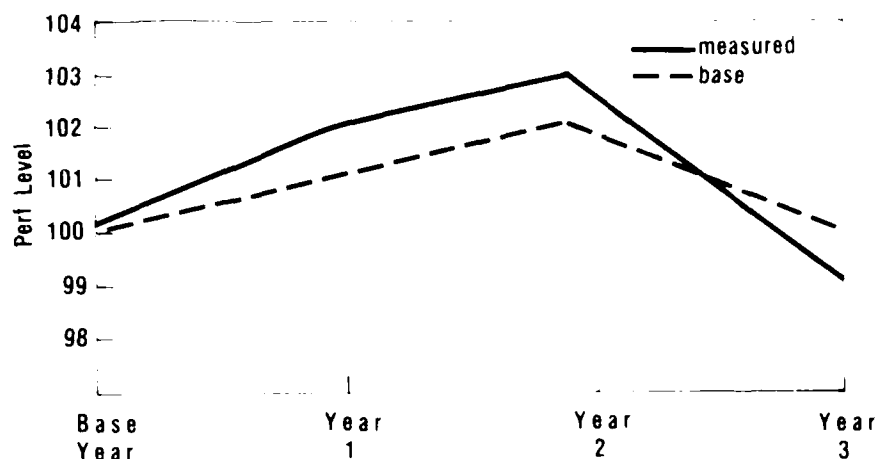
104
103
102
101
100
99
98
Perf Level
measured
base
Base Year
Year 1
Year 2
Year 3

Let us assume that performance is 100 percent in the base year. At year 1, measured performance rises 2 percent to 102, so the base rises by 1 percent to 101. At year 2, measured performance rises 1 percent to 103 (which is 2 percent above the year 1 base) so the base rises by 1 percent to 102. At year 3, measured performance drops 4 percent to 99 which is 3 percent less than the year 2 base; the base drops by 1 1/2 percent to 100.5.

The 6 percent (rounded off) improvement in performance is essentially equal to a 6 percent improvement in productivity since customer-related performance implicitly takes into account factors like timeliness, quality and quantity.

The 6 percent figure represents a return of 106 percent achieved for a cost of 100 percent. Thus, an improvement in performance has monetary value. When the annual budget of the performing organization is $1 million and the performance improvement is 6 percent, the 6 percent improvement has a monetary value of $60,000 since the organization produced $1,060,000 worth of work for a cost of $1 million.

If the payroll costs of the performing organization were reduced to $940,000 approximately, it would be expected to continue to produce $1 million worth of work, assuming continuation of the 6 percent performance increment. In this way, the performance improvement could be translated into monetary savings. Alternatively, the payroll could be [illegible] with performance [illegible] percent [illegible].

As the measured performance [illegible]

original performance standard since increasing it as a function of improved performance could reduce incentive for further improvement. Should it be decided to change the base as a function of performance, and we do so recommend, a reasonable formula might be that the base will change by half the amount of the performance change. Figure 1 illustrates this approach.

One concern raised about customer satisfaction ratings is they are subjective. When one has many customers, the average of a number of ratings converges on objectivity. While some customers will like the performing activity and others will dislike the activity, the average of a number of customers tends to remove the emotional bias of individual customers and to yield an unbiased or objective rating.

Another concern is that while customer satisfaction is an important indicator of performance [illegible]

■ [illegible]

satisfaction rating for it is the integral the summation of all other performance indices. While this contention is not rigorous, it is doubtful that any number of additional indices could be combined to yield the desired rigor. the single index customer satisfaction may therefore be as good an indicator of performance as we are likely to get with multiple index measurements. And most important, the single index approach offers simplicity.

A performing activity may have many customers and a commensurate variety of report card rating criteria. But a well-designed report card based on aforementioned factors would probably have generic utility. Some customers are more important than others and it may be desirable to use a weighted averaging system like the Oregon Matrix to develop an overall customer satisfaction rating. However, because of uncertainties attending the process, it is not clear that weighting results in a more meaningful overall rating. Therefore, it may be preferable to count each customer as equal when averaging the results.

It is important to note that for each organization, using a single macro performance measurement system to report productivity gains to higher authority does not preclude using multiple macro performance measurement systems for internal control

Macro measurement systems used for internal control and reporting are known as blue loop systems. macro measurement systems for internal improvement are known as red loop systems. The blue loop red loop notion and nomenclature are taken from the writings of Dr. Scott Sink, Director of the Virginia Productivity Center. Red loop systems can be used to provide data on things like numbers of drawings or reports produced, employee turnover, and timely handling of correspondence. They can and will be used to indicate local performance by each activity on elements of its productivity plan. i.e. improvement to quality of work life, employee training, improvements to acquisition process, identification and removal of productivity roadblocks, adoption of participative management and performance action teams. Only the blue loop macro performance measurement system based on customer ratings will be reported to higher authority because it is the integral of all of the red loop measurements.

The proposed customer satisfaction measurement method should enable us to determine where we are during our journey toward improved productivity, with sufficient precision and without undue complexity. This in turn should encourage and assist the work force to meet and surpass productivity improvement goals ■

Ron Harman, deputy project manager for ACPERS said the three systems being phased out are the Standard Army Civilian Personnel Management Information System used by most installation CPOs, the Corps of Engineers Management Information system, Personnel Accounting, and the Civilian Personnel Accounting System and the Headquarters Department of the Army Civilian Personnel Accounting System.

Hardware, software, and communications requirements for the ACPERS system approved in August, Harman said. He added that once the system became fully operational in 1988, the Army will save approximately $8 million per year in equipment leasing costs.

Harman emphasized that ACPERS will replace all the current civilian personnel systems.

nhanced timeliness and data quality benefit program managers when contract performance reports are submitted via electronic transmission. A system for electronic reporting, Associate Contractor Report Submission Interface Subsystem (ARIS), has been implemented at the Ballistic Missile Office (BMO), Norton Air Force Base, Calif. Using this system, contractors can transfer contract performance data directly to computer data storage at the BMO, where it is processed to provide briefing documents for contract analysts. The system uses communication protocols which detect and recover from noise interference during transmission; thus, standard voice-grade telephone lines can be used. Performance evaluation for contract reports electronically submitted can be completed about 3 weeks sooner than for those submitting hardcopy reports by mail.

The fictional program control analyst reviews calculations of recent cost performance report data, paying attention to the contractor's estimate-at completion values. Realizing the general's briefing is within the hour on the internal program office estimate to complete the project and the contractor's corresponding value, the analyst ponders many questions. Why are there differences in the numbers? How do I reconcile values?

The report shows data to be 50 days old. After the contractor's accounting period closed, 22 days were given to preparing the report and 7 days to mailing; then it arrived on a Friday. Cost analysts could not load the computer until the following Wednesday. The key-punch operator transposed a number and the staff spent 2 days analyzing erroneous data before call to the contractor to find the fault. After the number crunches were completed, briefing charts were prepared and sent to the senior analyst for presentation to the general.

[illegible] so many days went by [illegible] processed report [illegible]

Concept of Electronic Transmission

[illegible]

CHANNELING DATA THROUGH AN AUTOMATED ELECTRONIC

Lieutenant Colonel Nick Abate, USAF
Robert L. Litle
Thomas Smihula

recognized the problem of timely data early in the development of the Peacekeeper program. Contractors require 'X' amount of days after the closeout of the accounting month to collect, analyze and report cost performance values. Mailing several copies of an often 300-page report consumes time and creates enemies in the corporate mail room. Automated analysis of the report requires initial loading of the data and an error check routine before substantive data analysis.

In 1983, the BMO Systems Information Directorate set out to develop a means to electronically transmit cost-performance report data via ordinary telephone lines from the contractor's facility to the BMO cost analysis computer. Obviously, the attempt was to cut out the middleman to save time and improve accuracy. Figure 1 shows data flow from contractor to the BMO via conventional and automated paths. Development of BMO software and procedures initially was accomplished by the Science Applications International Corporation (SAIC), which was under contract to develop a automated management information system.

Subsequent contractual actions comprised Decision Planning Corpora[illegible] Harris International In[illegible]

transmission system. Today, BMO receives the majority of its contractor cost-performance report data via this computer-to-computer interface system. As a result, the program control team can be ready to brief senior-level management on cost-performance data within 26 days after the closeout of the accounting period. This is a far cry from the aforementioned example.

Requirements for Automated Reporting System

Initiating an automated reporting system should impose minimal burden on contractors using it. Since cost-performance reporting normally will be an established activity of the contractor, using the system should not require extensive modifications of existing accounting and management procedures or require expensive software or hardware. Transmissions should be possible from personal-type computers equipped with modems using voice-grade telephone lines. The system should be available on a 24-hour basis on business days so that contractors in all time zones have equal access and may effectively schedule transmissions. When traffic requires multi-line communication should be used to minimize delay.

[illegible]

ELECTRONIC TRANSMISSION

Financial Data Base — M/FRAME or MINI — MICRO — Manual Entry — Hard Copy — MAIL — Hard Copy — Manual Entry — DATA ENTRY TERMINAL — PRIME 750 — CPADS Data Base

CONTRACTOR | BMO
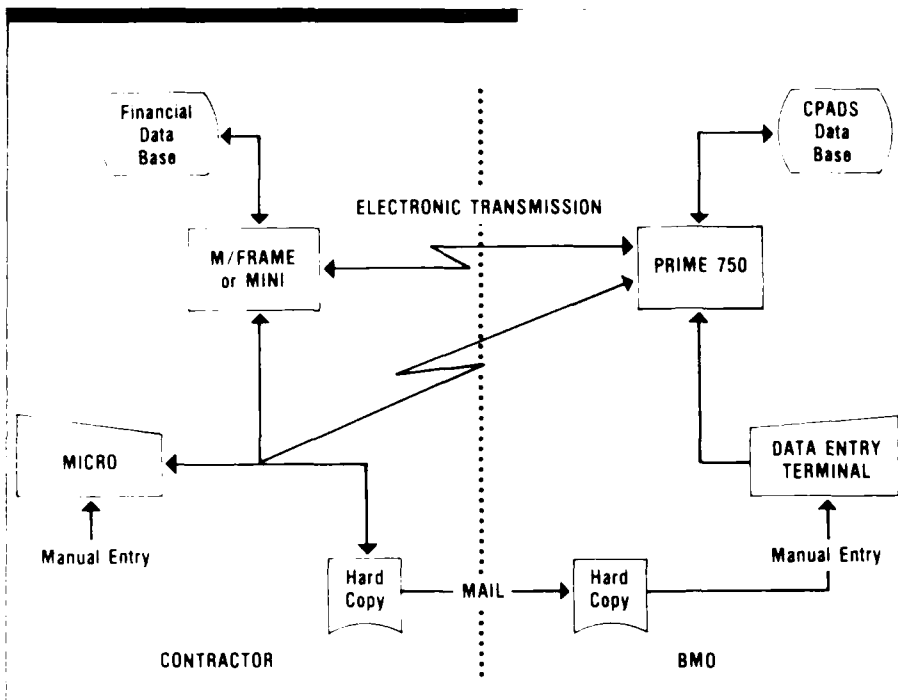
interference effects ('noise') which can corrupt data transmitted. The system, therefore, will require a transmission protocol detecting noise and allowing for recovery from its effects. If the line connection is broken before a transmission is complete, recovery procedures should allow resumption of transmission without requiring retransmission of data already received.

It is important that system users have convenient access to qualified support personnel who, in turn, have status-monitoring capabilities allowing them to respond to queries and suggest corrective actions. It is particularly important that these support functions include test facilities so that new users of the system (or current users wishing to test software or hardware modifications) can make test transmissions without interfering with day-to-day transmissions.

Security of data is a major concern for the contractor submitting reports and the agency receiving them. The idea of a telephone link to a computer system supporting sensitive data bases raises important questions. Could a competitor gain access to cost and funding data? Could data for a complete program be obtained by a hostile party? The system should allow only one-way program-to-program communication of data and should preclude user access to operating systems or data bases.

The ARIS System

The electronic transmission system satisfying these requirements was developed for report management for the Peacekeeper ICBM development program. It now is being applied for Peacekeeper production, Small ICBM development, and Advanced Strategic Missile System development management. This system is called ARIS (Associate Contractor Report Submission Interface Subsystem) and provides electronic submission capability for cost performance reports (CPR) and contract fund status reports (CFSR). The ARIS is resident on a Prime 750 computer system which supports the cost performance analysis and data subsystem (CPADS).

The transmission protocol used by ARIS is relatively simple but effective for error detection and recovery at low transmission rates. Three techniques are used.

First, a report is sent as a series of short records (less than 250 characters each). If an error is detected during the reception of a record, the reception program instructs the transmission program to resend that record. Thus, it is not necessary to have noise-free line conditions during the time it would take to transmit the complete report as one record.

Second, each record is encapsulated (i.e., a start sequence precedes the actual data and an end sequence follows it) noise characters that may

accumulate on the line between transmission of records are discarded until the start-of-data sequence is detected.

Finally, standard redundancy techniques are used to detect errors caused by noise during reception of the record. Vertical redundancy (parity) and longitudinal redundancy checking are used.

Main program modules and system data flow are indicated in Figure 2. The system's goal is data transfer for a contract to the CPADS data base for use by other systems preparing analysis and briefing documents. Auditing and archiving processes accompany the passage of a report through the system.

The Receiver

The reception program operates continuously as a background process on the host computer. It periodically checks the communication line and when a carrier signal is detected the program initiates data reception. The receiver communicates with the transmission program running on the contractor's computer by sending one of three 2-character control sequences. These respectively instruct the transmission program to send the next record, to resend the previous (i.e., an error was detected), or that the receiver is terminating the transmission (i.e., a non-recoverable condition exists, see Table 1). A log is maintained of all control sequences sent and error conditions detected; the data received are stored in a temporary file. Typical net reception rates are 5,000 to 5,500 characters per minute. This is about ten times the rate at which an expert word processor can input data.

When a transmission is terminated, the program verifies the contractor password, contract number and report type so that the data can be transferred to the proper permanent file for subsequent processing. When this is done, the receiver spawns several parallel processes and returns to its line-monitoring mode. These processes handle the archiving of the data as received, produce a hard copy for use by data entry personnel, and initiate the data verification process

■ *Lieutenant Colonel Abate is the Deputy Comptroller, Ballistic Missile Office, Norton Air Force Base, Calif. Mr. Taber is a Senior Programmer Analyst and Mr. Smihula is Manager, Software Support, both for DPC Halverson, San Bernardino, Calif.*

TRANSMISSION (Unformatted) → RECEPTION* PROGRAM → TRANSMISSION LOG

ARCHIVED TRANSMISSION LOG (Temp)

ARCHIVED REPORT AS RECEIVED

MODIFIED REPORT (Unformatted)

VERIFICATION PROGRAM* → EXCEPTION REPORT

MODIFICATION** PROGRAM

VERIFIED REPORT (Unformatted)

UPDATE** PROGRAM

ARCHIVED VERIFIED DATA

FORMATTED DATA FILES FOR CPADS → DATA BASE UPDATE

*BACKGROUND PROCESSES
**BATCH PROCESSES (Via Operator)

The Verifier

The successful termination of a data transmission means that the report has been received error-free in the sense that no loss or spurious introduction of data occurred. The verification program's task is to analyze the received data for content, and to produce a report showing inconsistencies in data that must be corrected before being committed to the data base.

Records in the report contain a single letter code identifying them by type. The first verification checks each record to see if it contains the correct number of data fields for that type of record, and that these are of the correct data type — text or numeric. Certain line items are required for each record type: the program checks if they are present. Cost performance data are typically related by line-item name to a master work-breakdown structure (WBS); line-item names are checked to make sure they agree with the current WBS for the contract. Finally, checks are made for numerical consistency. The output from this module is a hardcopy exception report.

Ideally, this report will show no exceptions. Should problems exist, it will be necessary to modify the data. The course of action followed will depend on the severity of the problem. Data entry personnel are authorized to correct obvious errors in spelling or punctuation, but substantive modifications can be made only with the approval of the program control analyst. If problems are severe, the analyst will request the contractor to resubmit the report.

After modification, the report is submitted again to the verification process. The report remains in this modify-verify cycle until all exceptions are resolved, and it is ready to be transferred to the data base.

The verification program requires considerable computer resources, especially processing time. For this reason, it runs as a background process so that operators may proceed to other tasks while the verification proceeds.

Data Base Updater

The ARIS transmissions are received in rather free format in order to spare the sender the overhead of fixed record and field lengths. Data bases however, impose strict formatting requirements on data which is transferred to them. The update program's first task is to reformat the data to CPADS specifications. The data is then committed to the data base and is available for analysis. The final task is to file a copy of the modified transmission in the archives.

1. Program-to-Program Communication

Data are sent by a *program* running on the contractor's computer to a *program* running on the BMO computer. This means the contractor does not "log on" to the BMO computer, nor does the BMO "log on" to the contractor's computer. Neither computer can issue commands to the other's operating system.

The two programs establish a communications link solely for data transmission purposes and the receiving program accepts data only. With this scheme, data bases and operating systems on either end are insulated.

2. One-way Data Transfer

Data received by the ARIS system are not "echoed" back to the sender. This means *data* flow only one way; from the contractor to the BMO. The receiving program sends only *instructions* to the transmitting program.

— Invalid Character
— Parity Error
— Checksum Error
-- Time Out

— Line Disconnected
— Record Loss
— Ten Consecutive Requests for Retransmission

Invalid character: One not in the allowed AHIS set.
Time out: 3 seconds of inactivity on the line.
Record loss: Successively received records don't have successive numbers.
Parity and Checksum errors indicate line-noise interference.

MONTH 1 | MONTH 2 | MONTH 3

DAYS

BRIEFING

ELECTRONIC
TRANSMISSION

RD   B
V

TIME →

← 22 Days →

BRIEFING

MANUAL

R RE   E V   D B

Close of
Accounting Period

End of Report
Preparation Period

B = Briefing Document   RE = Received Data Entry
D = To Data Base   E = Data Entered
R = Received   V = Verified

Utilities

Certain program modules accomplish tasks that are not apparent to the contractor submitting the report. These utility programs carry out auditing and archiving functions and enable the data entry and support staffs to perform their functions efficiently.

Data modification is done using a special-purpose editor specifically designed to handle data in the ARIS format. This has proved more efficient than general-purpose text editors.

Maintaining archives is an important function of the system. Immediately following reception, a copy of the as-received report is transferred to a file in an archive area of disk-storage. Reports for a 6-month period are retained in this archive. Reports for earlier periods are stored on magnetic tape. The final version of the report following modification, if any, is similarly archived. Should questions of data integrity arise, these two versions are available for comparison.

At each stage of a report's progress through the system, a time stamp is entered in a status file. This status file can be displayed at a terminal or printed. It provides a snapshot of the current month's activity.

How Well Does System Work?

From the contractor's point of view, the system has been easy to use. Typical start-up times for new users are 30 to 60 days. Using the ARIS system imposes no restraints on the contractor's hardware software configuration; however, the present trend is toward the use of personal-type computers to transmit data files which have been down-loaded from the main accounting system computers.

The Ballistic Missile Office believes the improvement in timeliness has been dramatic. For example, time-lines for two contracts, one using electronic transmission, and the other manual mail submission (Figure 3) show early availability of useful management data afforded by using ARIS. An additional benefit arises from elimination of manual data entry. Decreased personnel requirements have resulted in annual savings of more than $200,000.

In summary, ARIS has proved to be a simple-to-use, secure electronic transmission system. These features, together with its verification procedures, have established it as an important conduit for channeling management data to program management decisionmakers ∎

his paper describes the Air Force Systems Command (AFSC) formal long-range planning process—Vanguard. The AFSC is responsible for all research development, and acquisition of all new U.S. Air Force weapons systems. The AFSC considers long-range planning of critical importance—more than an academic exercise. The USAF ability to continue to confront successfully potential adversaries possessing numerically superior forces demands state-of-the-art quality weapons systems. Because the cost of research, development, and acquisition of new systems is continually rising while the Air Force budget is shrinking, decision-makers are forced to be more selective about approving requests for funds. The AFSC realized that a new approach was needed to gain support for research and development efforts. A formal system was adopted that provides an explicit plan—rooted in historical fact and concisely presented.

AFSC'S FORMAL LONG-RANGE PLANNING PROCESS

Joe E. Collins

Long-range planning does not deal with future decisions, but with the futurity of present decisions.

—Peter Drucker

Vanguard was initiated in 1978 to provide a process for documenting the using commands' needs and for focusing research and acquisition activities in AFSC to satisfy those needs. It has evolved into AFSC's formal long-range planning process and a principal instrument for dialogue with Air Force warfighting organizations.

Vanguard is a highly interactive process. Development planners at AFSC product divisions—located around the United States—work with Air Force major commands to measure programmed capability against the threat, and to identify future capability shortfalls in the Air Force's mission areas (Figure 1). Product division planners identify developing technologies and future weapon systems concepts to meet those needs. The HQ AFSC development planners integrate product division inputs into an overall plan and in turn, review that master plan with all participants.

Vanguard is a threat-based, user-oriented (requirements pull) planning system. Fiscal constraints based on historical experience and the postu-

lated future environment are imposed to develop estimates of future funding levels. Vanguard helps guide technology efforts in Air Force and industry labortories and identifies alternatives for future weapon systems that will meet the future threat.

Vanguard is one part of the complex effort to identify future Air Force needs and thereby provide focus for research and development efforts. It is not an attempt by AFSC to dictate to the Air Force which systems to buy. Neither is it the "final word" to industry on exactly which systems the Air Force will buy and when. However, it is the most intensive and comprehensive look at the future of which we in AFSC are aware.

Sub-Mission Plans

Mission area plans, corresponding to the ten mission areas in which the Air Force formulates its budget constitute the core of the AFSC planning structure (i.e., strategic offense, strategic defense, tactical). The foundations for the plans are a series of sub-mission plans which provide a greater degree of detail. Development planners at AFSC product divisions are responsible for the preparation and maintenance of the specific sub-

mission plans in which the divisions have particular expertise. For plans involving activities closely associated with more than one product division, a lead product division is assigned.

The sub-mission plans are based on requirements defined by the commanders and planners of Air Force operating commands—in conjunction with guidance from the Secretary of Defense and Headquarters U.S. Air Force (Figure 2).

Since the weapon systems we develop and acquire end up in the hands of operational commands, we want to start with a firm appreciation of what users' needs are. We do that primarily by meeting frequently with the users. One of the most publicized failures in business has been Ford's Edsel automobile produced in 1957. General consensus attributes the failure to incorrectly forecasting the potential market. A case study of the forecasting error revealed that the car industry's market forecasts did not consider what the customer wanted; rather, only what the manufacturers in Detroit had concluded the customer wanted. Vanguard's goal is to understand what the users of AFSC products want, document those users' needs, and discuss them with the users.

Vanguard's sub-mission plans assess Air Force ability to meet national defense needs now and in the future by using standard analytical computer models recognized and accepted throughout the Air Force. The sub-plans spotlight differences between our projected capabilities and tasks that must be accomplished.

Product division planners then propose a set of alternative weapon system solutions to correct each deficiency. The alternatives are based on maturing technologies from both USAF laboratories and industry research. Throughout this phase, the plans are fiscally unconstrained.

Because no one product division analyzes a total mission area plan, each product division's alternative solutions are forwarded to HQ AFSC for completion of the Vanguard mission area plans.
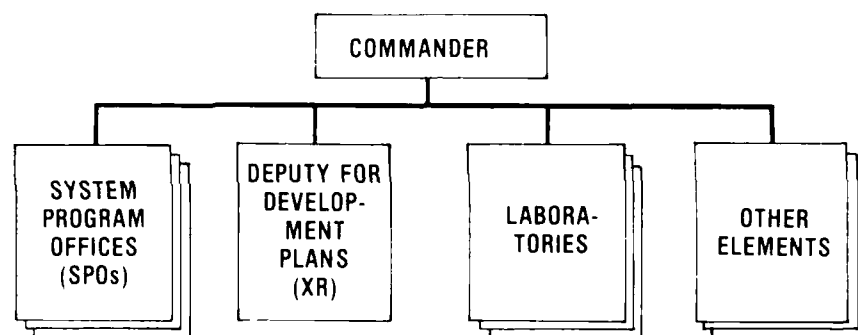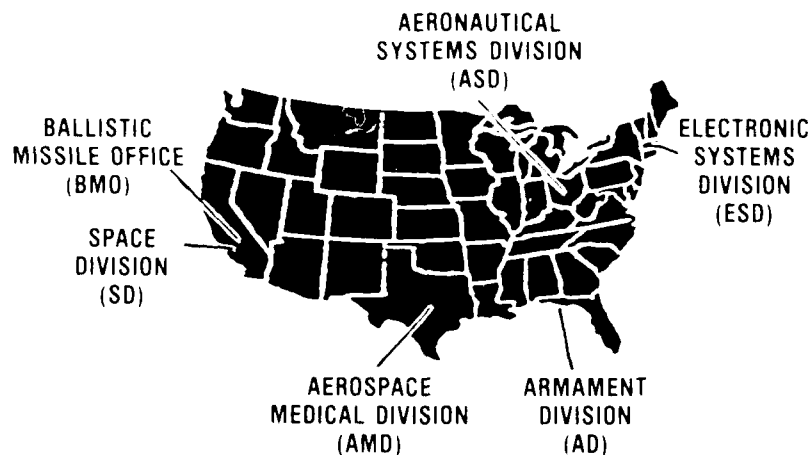
Master Plans

The sub-mission plans are consolidated by HQ AFSC planners into the mission area plans. An office of primary responsibility at HQ AFSC is assigned for each of the mission area plans. This grouping by mission area integrates the separate sub-mission analyses into cohesive packages that address total mission needs (Figure 3).

Plans are assembled in a two-step process. First, planners propose a candidate 20-year investment program that is not fiscally constrained. The time-phased, total estimated cost of the candidate weapon system acquisition programs normally exceeds the projected available financial resources.

In the second step, plans are tailored — by deleting some acquisition programs and delaying the starts for others — to select the investment program that will best meet needs within realistic budget constraints. In developing a Vanguard fiscal constraint, we look back 20 years at those investment funds that AFSC executed for the users. The investment funding averaged 1.2 percent annual real growth. For Vanguard, then, we use 1 percent annual real growth projected from the budgeted fiscal year throughout the 20-year period.

This phase of the Vanguard process occurs in consultation with the operating commands. Such coordination ensures plans address the highest

AERONAUTICAL SYSTEMS DIVISION (ASD)

BALLISTIC MISSILE OFFICE (BMO)

ELECTRONIC SYSTEMS DIVISION (ESD)

SPACE DIVISION (SD)

AEROSPACE MEDICAL DIVISION (AMD)

ARMAMENT DIVISION (AD)

COMMANDER

SYSTEM PROGRAM OFFICES (SPOs)

DEPUTY FOR DEVELOPMENT PLANS (XR)

LABORATORIES

OTHER ELEMENTS

priority goals, overcome mission area deficiencies, and deliver the capability needed to satisfy future mission requirements.
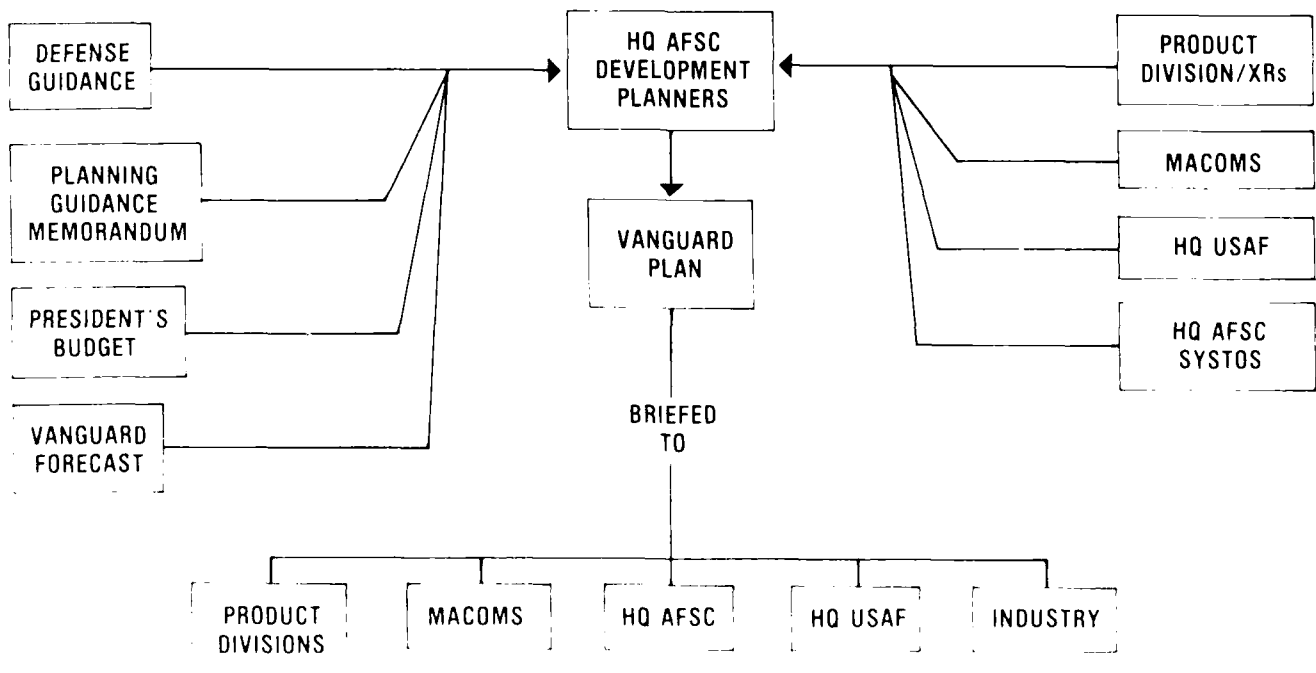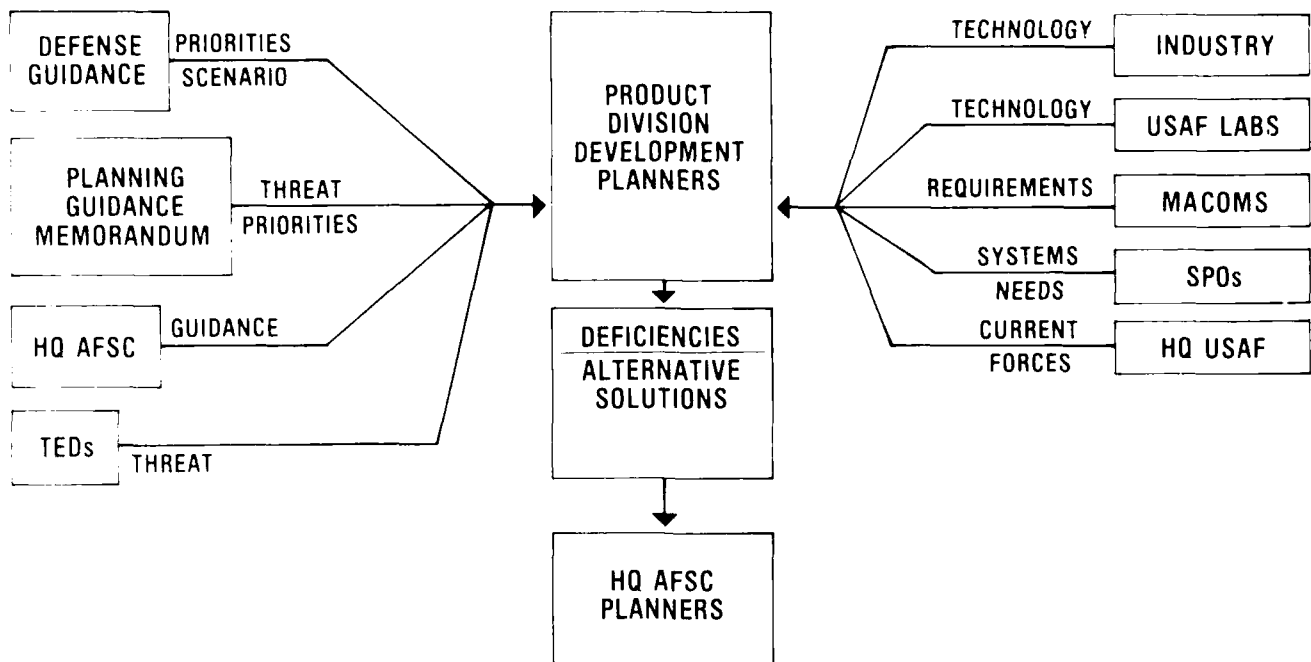
The HQ AFSC development planners brief the final, constrained mission area plans to the product divisions to ensure the plans are accurate, reasonable, and executable.

Two Types of Planning

Requirements Pull. Vanguard documents the "requirements pull." It responds to the using commands' projected requirements by focusing development planning on the most serious deficiencies we will encounter during the next two decades. The mission area plans serve two broad purposes

—They provide for regular and formal coordination of needs and potential alternative solutions between AFSC and the operating commands. Operating commands' requirements are evaluated in the context of Defense Department and Air Staff guidance. Alternative systems to satisfy operators' needs are analyzed and comparatively evaluated with the operators. They identify technologies which must be matured to support future preferred systems; these are provided to AFSC laboratories for use in developing technological investment strategy.

■ *The author serves at Headquarters Air Force Systems Command, Andrews Air Force Base, Md.*

Diagram 1

DEFENSE GUIDANCE — PRIORITIES / SCENARIO →

PLANNING GUIDANCE MEMORANDUM — THREAT / PRIORITIES →

HQ AFSC — GUIDANCE →

TEDs — THREAT →

PRODUCT DIVISION DEVELOPMENT PLANNERS

← TECHNOLOGY — INDUSTRY

← TECHNOLOGY — USAF LABS

← REQUIREMENTS — MACOMS

← SYSTEMS NEEDS — SPOs

← CURRENT FORCES — HQ USAF

↓

DEFICIENCIES ALTERNATIVE SOLUTIONS

↓

HQ AFSC PLANNERS

Diagram 2

DEFENSE GUIDANCE →

PLANNING GUIDANCE MEMORANDUM →

PRESIDENT'S BUDGET →

VANGUARD FORECAST →

HQ AFSC DEVELOPMENT PLANNERS

← PRODUCT DIVISION/XRs

← MACOMS

← HQ USAF

← HQ AFSC SYSTOS

↓

VANGUARD PLAN

↓

BRIEFED TO

PRODUCT DIVISIONS — MACOMS — HQ AFSC — HQ USAF — INDUSTRY

Technology Push. If we in the military have a blind spot it could be in not adequately foreseeing the revolutionary. The requirements pull process needs a balance, a technology push that probes beyond evolutionary advances.

Project FORECAST II completed in early 1986 provides some of that balance. It searched for and identified emerging technologies that might revolutionize capabilities producing quantum leaps instead of evolutionary steps. To that end, Project FORECAST II identified 39 potential technologies and 31 projected systems that could revolutionize the way the Air Force carries out its mission in the 21st century.

Where appropriate, these systems and technologies are incorporated into alternative solutions to correct Vanguard mission area deficiencies.

Additional Vanguard Uses

The primary function of Vanguard is to identify possible new program starts for the next 20 years to alleviate deficiencies during that period. In the broader context, Vanguard also highlights potential impacts on new systems on AFSC's organizational structure and test resource needs.

The Air Force Systems Command is committed to executing the most efficient programs possible. One way to improve efficiency is to exploit leverages available in pre-full-scale engineering development; studies indicate 85 percent of the total program cost is locked in during these early activities. Early cost estimates and emphasis on supportability at the onset of program formulation provide needed insight for decision-makers. Vanguard, through the examination of alternatives, is one method used by AFSC for reduction of risk and cost. Also, AFSC is working closely with the Air Force Logistics Command to incorporate logistic considerations up front and early on in the system planning process.

Presentation

Results of the Vanguard analyses are presented in two ways: briefings and the Vanguard Planning Summary report.

An executive-level briefing for each plan is presented to the product division commanders, Air Force major commands, the HQ USAF board structure, and industry.

The Vanguard Planning Summary is produced annually to document the mission area analyses. It is a comprehensive description of a recommended research and development program strategy which represents the highest potential return on investment during the next 20 years. The document is available through the Defense Technical Information Center, Building 5, Cameron Station, Va. 22314. ∎

Reference

1. Marketing Myopia, *Harvard Business Review*, July-August 1960, p. 45.

The Army Troop Support Command's Belvoir Research, Development & Engineering Center has initiated a program to encourage and facilitate increased interaction with academic institutions. Contract negotiations are under way with eight leading universities where faculty and graduate students are conducting research in areas of interest to this Center.

The dwindling supply of scientists and engineers is confronting us with an ever-increasing problem and we must take steps to overcome this situation, commented Dr. Karl Steinbach, the Center's Chief Scientist. Strategy at Belvoir includes active recruiting at college campuses, cooperative education programs, summer faculty employment, technical seminars to solicit support, a select high-technology intern program, and training programs designed to keep the workforce abreast of technological advance.

elsewhere. One of our most exciting and promising initiatives, Steinbach said, is to augment the Belvoir workforce by engaging university research teams in collaborative efforts with our scientists.

The Center established a University Relations Action Group which has initiated discussions with 17 universities throughout the United States. The group's primary task is to relate the Center's technical problems to research interests of established university teams. A key feature is emphasis on collaboration calling for active participation by Belvoir scientists, graduate students, and faculty members. ∎

George Mason University, in conjunction with the Society of Logistics Engineers, will offer continuing education courses in logistics beginning in September and continuing throughout the academic year. All courses will be taught at the George Mason University Professional Center, 3401 North Fairfax Drive, Arlington, Va. Some courses, which provide background and context on the role of logistics within the organization, have been designed for the novice in the field. Of interest to the professional with experience in logistics will be courses which emphasize more specific logistics skills and mathematics.

Introductory-level courses include the Integrated Logistic Support Program, Logistic Support Analysis and Logistic Support Analysis Record (LSA/LSAR), Quantitative Methods for Logistics, and Introduction to Configuration Management; the last is followed by Software Configuration Management and Software Quality Assurance. Other courses include Maintenance Demand Modeling, Logistics Systems, Logistics Support, and the review course for the certified professional logistician exam.

For further information, call the George Mason University Off-Campus Instruction office at 323-2394. ∎
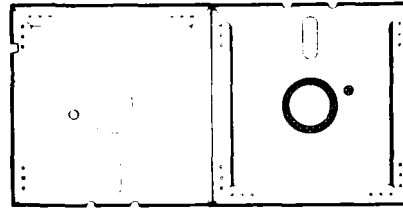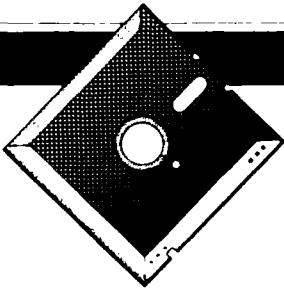
SOME TIPS ON ACQUISITION MANAGEMENT

Lieutenant Commander R. W. Morrison USNR

s weapons systems become more software dependent weapons system acquisition managers are discovering more frequently that they are software acquisition managers. This article contains guidance on the management of a software development.

Management goals of the software development process are to produce cost-effective, reliable, modifiable and maintainable software consistent with error tolerances of the system. The nature of the software development process provides many opportunities for a misdirected management emphasis to exceed required goals in one area at the expense of another. For example, excessive emphasis on software error reduction could result in software that is well below the error tolerances of the system but has an excessive development cost and schedule. In other cases, the emphasis could be on minimization of development cost and result in software that is difficult to maintain during the life of the system. This article addresses software development methodologies, management issues, risk management, and sources of assistance for achieving the desired software acquisition goals.

Software Development Methodologies

There are many software development methodologies and, as software development technology evolves, more methodologies are likely to appear. The contractor's choice of software development methodology depends on various factors. Some methodologies work better with certain types of applications; others work better with certain languages. The contractor's experience with the particular application or with similar applications can influence the choice of development methodology. While military software development standards generally are designed around "top-down" development, this is clearly not the best choice in all applications and environments. In general, the procuring agency should strive *not* to prescribe a specific methodology to the contractor, but should evaluate the methodology proposed by the contractor to ensure it is an effective, uniform, and disciplined approach to software development resulting in software that is easily supported and maintained. Whichever software methodology is chosen, there must be a consistent, systematic, and structured approach to deal with each software development activity requirements analysis, design, code, integrate, and test. The methodology must be documented and procedures must be followed.

All well-structured development methodologies will include several phases of development. The six phases
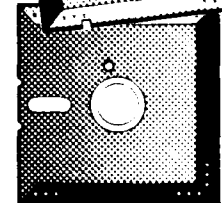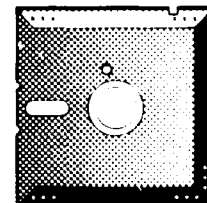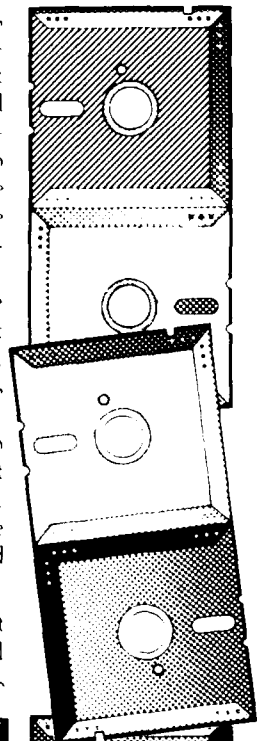
■ *Mr. Morrison is a reserve with the Naval Air Systems Command He is associated with Honeywell, Inc., Reston Va.*

described in MIL-STD-2167 are: Software Requirements Analysis, Preliminary Design, Detailed Design, Code and Unit Test, Computer Software Component (CSC) Integration and Computer Software Configuration Item (CSCI) Testing. The phases of software development can occur during any of the phases of weapons system development (i.e. for a variety of reasons, new software can be developed during any phase of a weapon system life cycle. Also for various program reasons, such as modified requirements during development, or inclusion of already developed software as part of a new development, some phases can be abbreviated or non-existent for portions of the software. Likewise, not all portions of software development need be in the same development phase at the same time. Despite the need for flexibility in the phasing of software development, each phase must be planned and managed to ensure that basic software and any modifications required to the basic software are addressed systematically.

## Management Issues in Software Development

There are four fundamental management issues to be addressed in the early stages of software development. Generally, they are addressed in any contractor's proposal, but must be managed and monitored continually to ensure satisfactory solutions. In many cases, these are the same issues a manager would encounter in any acquisition task; in other cases, the issue is specific to the fact that the development is software.

The first issue covers resource availability and organization. Not only must the contractor's assets be monitored to ensure availability of the proper skill and experience level to perform the development successfully, but

the software acquisition manager must ensure that support organizations monitoring technical and managerial status of the development have proper assets to evaluate progress accurately. The personnel and hardware assets for contractor and the government support organizations must be monitored continually during software development to ensure that asset constraints are not causing a de-emphasis of some risk-reducing activities such as design reviews.

The next issue addressed is the adequacy and achievability of the development schedule and milestones. Milestones must be quantitative measurable events from which reasonable estimates of the development progress can be ascertained. The schedule must provide sufficient time for the contractor to perform development tasks, but it also must ensure that the government has sufficient time to perform its required functions such as review documents or evaluate designs. The contract schedule must avoid inadvertent costly resource fluctuations at contractor or government support organizations through arbitrary compression of development phases or delays between development phases.

The third issue involves data rights and documentation requirements of the software. In situations where commercially developed software is used as a portion of a system, data rights and documentation available for purchase by the government can vary by component within the total software package. This rapidly can become a complex issue as the acquisition manager tries to ensure that the government acquires needs to perform the mission during the life of the system. This can result in increased acquisition costs (paying for data rights to commercial development or paying for customized development) in order to reduce life-cycle costs (providing
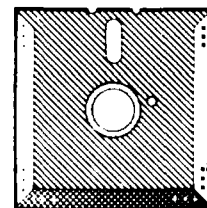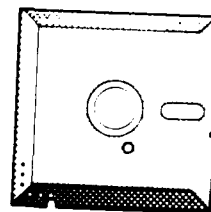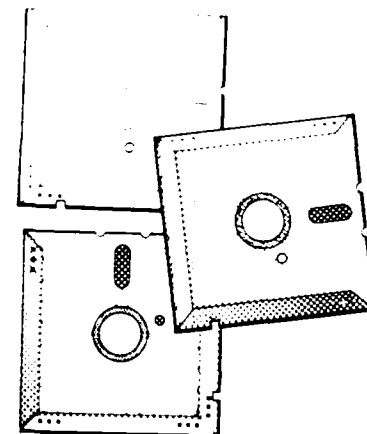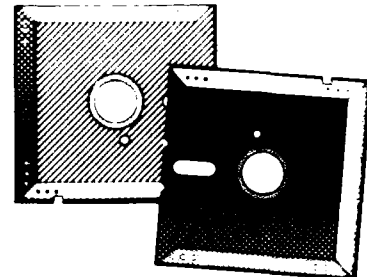
apability for easy source code updates in the future. Since the purchase of data rights can be costly, a proper technical assessment must be made by qualified personnel regarding what data rights are needed based on a realistic assessment of the amount of software maintenance and modification expected during the life of the system.

The fourth issue is establishment of software quality evaluation criteria. Few problems can disrupt a software development program like a disconnect between the procuring agency, or its support organizations, and the contractor developing software concerning evaluation criteria for successful passing of a program milestone. These disagreements could concern adequacy of preliminary documentation submittals, developmental tests to be conducted on software, or differences in preferences for coding standards or software development practices. When disagreements occur, the procuring agency must evaluate their significance and substance in terms of program impact. Does the disagreement reflect only personal preferences of the participants? There are ways to develop software, and usually a variety of ways to interpret data item descriptions. Or does the disagreement reflect risk to the program in the quality and completeness of the software being developed? Not an easy determination, this often causes things to be fixed that were not broken, a surprise to the contractor which can divert resources from the real task, resulting in schedule slippages and cost overruns. Sometimes, disagreements can be avoided if portions of early design reviews and progress meetings are dedicated to getting agreement of the parties on templates, formats, and examples of documents, code, and test procedures.
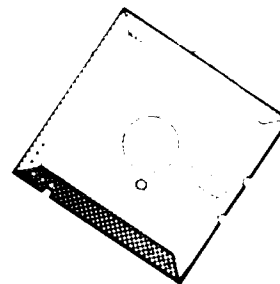
Software Standards and Data Items

Military standards can be acquisition aids to the buyer and seller of military products and services. For the seller, military standards identify requirements applying to the product or service. For the buyer, military standards represent an accessible, tailorable package of requirements to be levied on a seller to ensure a quality product. Because of the different types of software development for different applications, care must be exer-

used in the application of military standards. The proper use approach to application of requirements does not necessarily improve quality of the software developed, but certainly affects cost and schedule for development. Application of unnecessary requirements can significantly increase the cost of software development without tangible benefit to the Department of Defense. Military standards must be tailored for the development to avoid wasting limited resources of the weapon system acquisition. This is not an easy task.

Acquisition managers are supported by specialists in each area of expertise (logistics, documentation, testing, financial management, contracting) who may not have the larger view of program needs. Too often, when an acquisition manager attempts to tailor out a redundant military standard requirement from the program, a specialist involved may perceive this as an attack on his specialty in general. This results in an overwhelming resistance to the deletion of the requirement in question, causing the acquisition manager not to remove the requirement. The result is that military standards seldom are adequately tailored for any particular software acquisition.

DOD-STD-2167. This standard is the cornerstone of the current software standardization effort in the Department of Defense. It contains requirements for the development of Mission-Critical Computer System (MCCS) software. It contains requirements that can be applied to virtually all types of software development but, in containing all of those requirements, it contains more requirements than would generally be neces-

sary on any one software development. Significant effort must be expended by contracting agencies to ensure that they tailor out unnecessary requirements of the standard. Some success has been realized in this area by using combined government-industry working groups to set guidelines for the tailoring of MIL-STD-2167 for specific types of software development.

MIL-STD-1521. This standard prescribes requirements for conduct of technical reviews and audits on systems, equipment, and computer software. Again, in trying to be all things to all programs, this standard requires tailoring for any particular acquisition. For software acquisition there is room for interpretation in the requirements of this standard. Additional specifics generally need to be added to clarify requirements for a particular software development, those avoiding independent interpretations and misunderstandings between contracting agency and contractor regarding what is required and expected.

MIL-STD-490. This standard establishes uniform practices for specification preparation. Software acquisition managers must evaluate the level of specification required for their programs.

MIL-STD-483. This standard establishes uniform configuration management requirements that must be tailored for any specific software acquisition.

Software Data Item Descriptions (DIDs). The DOD-STD-2167 identifies data items that can be required on any software acquisition. They fall into four categories: management, engineering, test, and operation and support. Software data items are used for

three purposes: 1) ensure contractor is making appropriate progress on the software development and is maintaining cost schedule control; 2) ensure interpretation of technical performance requirements by software developer are consistent with interpretation intended by procuring agency; and 3) ensure receipt of sufficient information about software so that it can be maintained during system life cycle. Each software acquisition manager must determine what information is required for the program in each of the above areas, and which require only that information. Unnecessary data items cost the government money because the contractor must prepare them, also require government resources to review submissions. It is particularly important for software acquisition managers to review resources available for evaluating submitted data items, especially those for evaluating management performance or requirements interpretation. If there is no one to review a submitted item properly, and it is a necessary item to begin with, the program has a significant risk.

Once the software acquisition manager defines information requirements necessary for software development, there is often an opportunity for cost savings in the acquisition. Cost savings can be realized by authorizing vendor format for submission of data items. This allows the contractor to submit information in whatever format in use for management of the contract without having to reformat data to specific data item description. Benefits of using this technique must be evaluated however against the additional review process that may be required by the procuring agency to glean information desired from an unfamiliar format.

Risk Management in Software Development

There are four basic types of risk in the development of software.

1. Software does not meet requirements. Basic requirements for the performance of the system must be translated into a software specification. This specification must then be translated into operating computer code. Each of these translations provides significant communications difficulties in that terminologies used by the persons that identify requirements are probably not clearly understood by persons who write computer code and vice versa. Persons involved in translating the requirements into a software specification must be sufficiently familiar with system operational requirements and with the process of developing and executing software to ensure there are no significant communication difficulties in this process. Program managers must ensure there are sufficient technical reviews during software development for early identification and correction of communication difficulties.
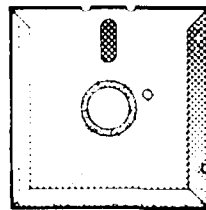
2. Cost Schedule overruns common in software development occur due to the innate difficulty in software development of accurately measuring work accomplished and estimating work remaining. Measuring progress in software development is analogous to measuring progress in a golf game. On a 300-yard hole, the first drive is 230 yards. The second shot arrives on the green. Is this hole 2/3 complete, half complete, or are four putts remaining? In software development it is at least this hard to estimate progress. Many measures of progress used in the past (such as number of lines of code finished vs. number of lines estimated for the total system) have proved to be unsuccessful in estimating the actual amount of work remaining in a software development. The most successful techniques used for measuring progress have involved the analysis of software documentation submittals (as data items) during the development cycle.

3. Resulting software has a higher than expected life-cycle cost. This situation can arise even when software development meets system requirements and is performed within cost and schedule constraints. This is usually a manifestation of deficiencies in the software development process. Because software is essentially a reflection of a software engineer's thought process in creating a solution to a problem, it is possible that after software is developed it will be difficult or impossible for another person to reconstruct this thought process to modify, maintain, or correct the resulting computer code. This often is caused by either inadequate constraints on software engineers or programmers in the use of techniques for manifesting a thought process in computer code (coding standards) or by inadequate software documentation. Note that good coding standards and practices are more important in reducing life cycle costs than excessive documentation. It is easier to maintain good well-structured code with minimal documentation than to maintain bad code with great documentation.

4. Insufficient baseline control which can include evolving requirements and changes in technical data during software development can have impacts permeating the software development. Interfaces designed documented and reviewed can be changed drastically by things that appear on the surface to have negligible impact. Sometimes changed requirements can invalidate the selected software development methodology. As circumstances change during a development program, the software acquisition manager constantly must be aware of the impact on the program of baseline changes. When a program change affects work accomplished and is approved at previous major milestones such as design reviews allowing modifications can have serious program impact. Forcing such changes into the software without allowing schedule time for incorporation into previous work and new review processes usually results in other program delays when it is discovered software does not interface

as required or performs differently than expected. It can increase life-cycle costs when documentation delivered early in the program does not reflect software delivered later.

Note that unless the software acquisition manager is familiar with the specific type of software development being managed, it is usually impossible to assess accurately the four risk categories. Expert assistance must be acquired either through specific addition to the acquisition manager's immediate staff or by using a support organization.

Sources of Assistance

Two types of government organizations are available to provide assistance to software acquisition managers depending upon their needs. They are the defense colleges and the Contract Administration Service (CAS). The defense colleges, like the Naval Postgraduate School or the Defense Systems Management College, have research resources available to assist in investigating specific software development questions. They have assisted in estimating the size of software projects and evaluating software development methodologies. There are several CAS organizations: AFPRO (Air Force), ARMPRO (Army), DCASMA DCASPRO (Defense Logistic Agency), and NAVPRO (Navy). They can provide assistance to software acquisition managers throughout the life cycle of a software system. The CAS mission normally starts after the award of a contract but, as part of its stated mission, can perform pre-award surveys of prospective offerors. This helps the procuring agency ensure these offerors are capable of meeting subsequent contractual obligations. The pre-award survey evaluates offerors' management and technical expertise, financial posture, and reviews their records of performances. The CAS involvement after contract award centers around its surveillance and evaluation of the contractor's compliance with the terms and conditions

the individual CAS office in a geographic area can be small and have a charter to monitor different hardware and software developments. The result is that expertise varies significantly. The procuring agency should review available CAS capabilities when evaluating options.

In addition, the procuring agency can use another contractor to oversee the contractor developing the software. This can be an independent validation and verification (IV&V) contract or other types of support contract. This approach has risks but may constitute the only source of qualified technical assistance to the software acquisition manager. Risks to be aware of and managed include:
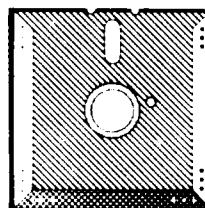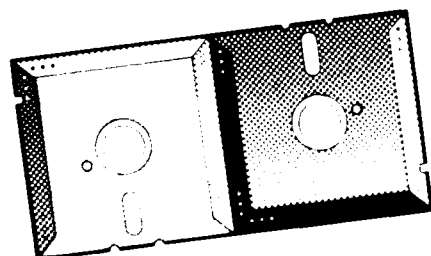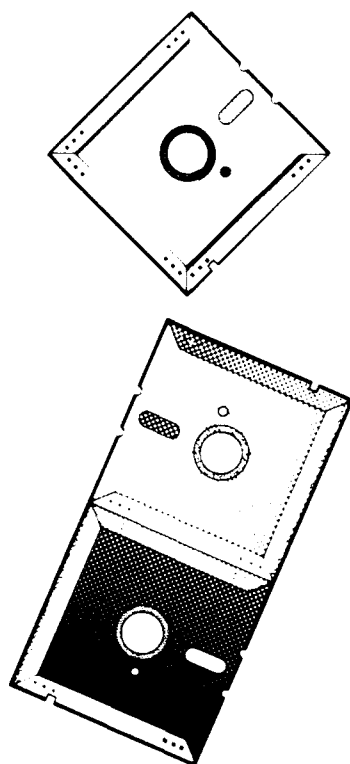
Ensure the reviewer is actually providing qualified personnel to perform an appropriate technical review of the specific type of software under development. It is not unknown for contractors to use the review of another program as a training ground for their personnel. It is not unknown for a contractor to use these review activities as a government funded training program to obtain insight into the techniques employed by other contractors to establish a competitive edge in a field.

– Ensure that objections and comments raised by the reviewing contractor involve substantive issues actually reflecting risk to the program, rather than another agenda of the reviewing contractor such as ensuring follow-on work or making a name in the field of software review.

With this in mind, using qualified contractor support can be a cost-effective management tool in the acquisition of good software ∎

References

DOD-HDBK-287
DOD-STD-2167
MIL-STD-483
MIL-STD-490
MIL-STD-1521

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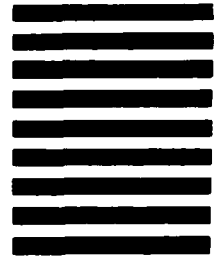
People on the Move

Lieutenant Colonel James R. Armstrong, USAF, is a Professor of systems acquisition management in the [...] Management Department [...] assignment was at the Pentagon as a [...] Program Manager for [...] Tactical Communications [...] Lieutenant Colonel [...] holds a BS degree in [...] engineering from [...] Institute and a MS degree in systems management [...] University of Southern [...]

Lieutenant Colonel Michael J. Browne, USAF, is a Professor of [...] Management Acquisition Management Laboratory. He graduated in December 1986 from the Program Management Course at DSMC [...] He was assigned to Air Force Systems Command Headquarters, Andrews Air Force Base as Chief [...] Division. Lieutenant Colonel Browne holds a BS degree in [...] engineering from the New [...] Institute of Technology, an MS degree from the Air Force Institute of Technology, an MB degree from the University of West Florida and a PhD degree from North [...]

Commander James H. Hoffman, USN, is a Professor in the Acquisition Management Laboratory. In his last assignment he was the Branch Head [...] FLTSAT Satellite Communications and Submarine Satellite [...] Commander Hoffman holds a BS degree from North [...] and an MS [...]

Lieutenant Colonel Sammie G. Young, USA, is a Professor of [...] management in the [...] Management Department [...] faculty, Lieutenant Colonel Young holds a BS degree in economics from Austin Peay University and an MS degree in logistics management from the Florida Institute of Technology.

Gains

Shelley Fink, Research Directorate Department of Research and Information

Alumna

Robert W. Kerr, PMC 83-2 graduate, has been named Director, Quality & Productivity Office, Ford Aerospace & Communications Corporation. He is responsible for quality and producibility improvement initiatives for the corporation's six divisions and operations. Mr. Kerr has been with Ford Aerospace for 21 years serving in engineering and program management assignments.

Robert L. Woods, graduate of PMC 79-1, Space and Naval Warfare Systems Command, Washington D.C. has won the Navy ACTION 88 Excellence Award for Acquisition Streamlining category, Professional for FY 88. The Honorable Everett Pyatt Assistant Secretary of the Navy, Ship building & Logistics, was host at the awards ceremony.

Losses

Lieutenant Colonel Richard L. Banks, USA, Director of the Program Management Course School of Systems Acquisition Education retired. He entered the Army in 1966 and his military service includes tours in Vietnam, Germany and Korea. Lieutenant Colonel Banks is now associated with Tracor, Austin, Texas as a program manager on a new development program.

SFC Paul Miskanin, USA, Technical Services Directorate, retired.

EN Denise Nadolski, USN, separated from active duty.

Dr. Herbert Puscheck, Army Chair to the Office of the Secretary of Defense Program Analysis and Evaluation. He is the Deputy for general purpose programs.

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