March-April 1990

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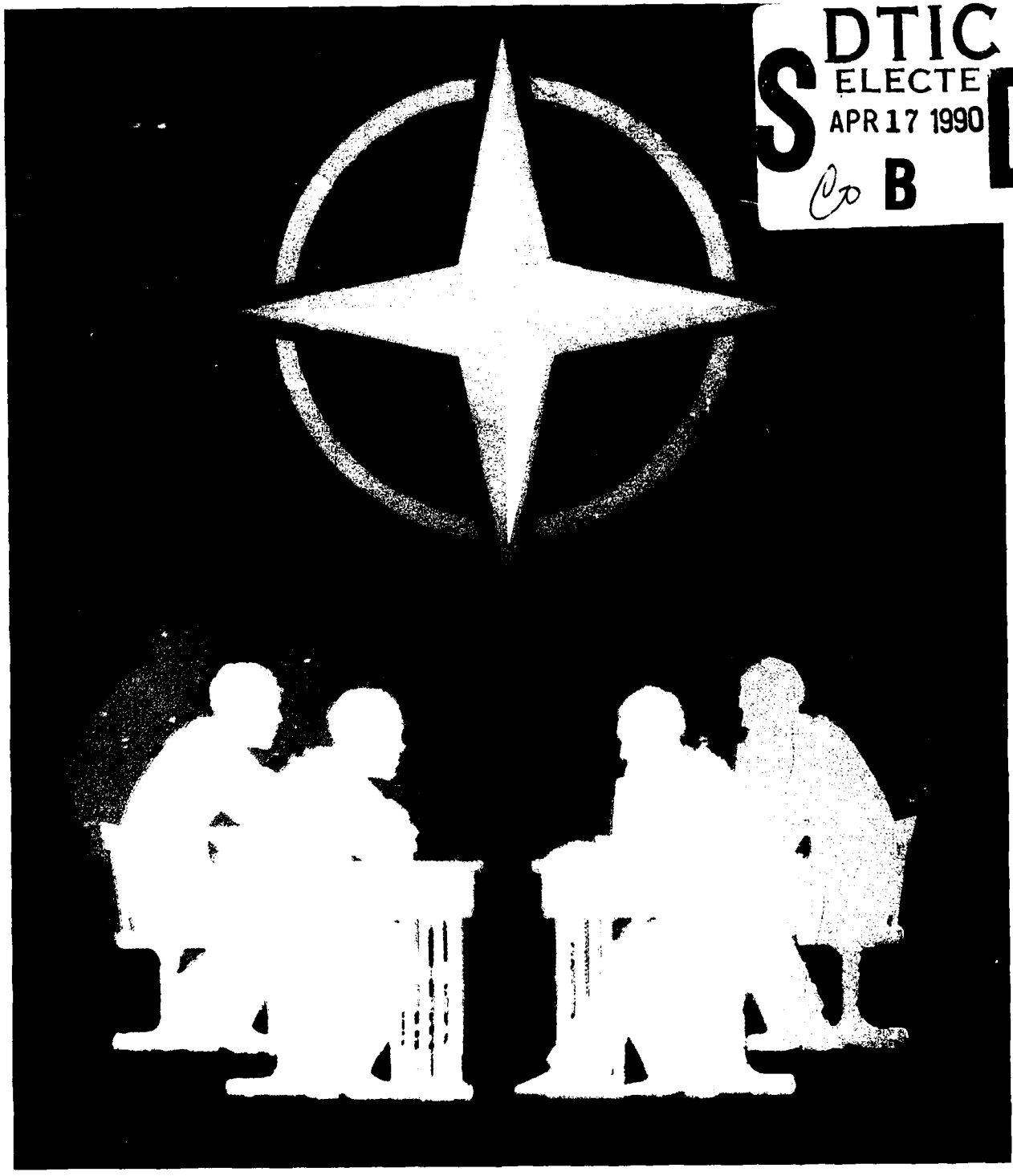
PROGRAM manager



Journal of the Defense Systems Management College

PROGRAM manager

Journal of the Defense

Program Manager (ISSN 0199-7114) is published bimonthly by the Defense Systems Management College, Fort Belvoir, VA 22060-5426. Non-government employees and organizations may subscribe at $7.50 annually through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Second class postage paid at Fort Belvoir, VA.

POSTMASTER: Send address changes to *Program Manager*, Defense Systems Management College, Fort Belvoir, VA 22060-5426.

Vol. XIX, No. 2, DSMC 95

Systems Management College

Whenever in this publication "man," "men," or their related pronouns appear, either as words or parts of words (other than with obvious reference to named male individuals), they have been used for literary purposes and are meant in their generic sense.

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THE INTERNATIONAL IMPERATIVE:
RHETORIC AND REALITY OF ACQUISITION FOR DEFENSE IN THE 1990s

Colonel M. Rex Stephenson

Acknowledgment: Valuable support and guidance in preparing this article was provided by Professors Chris Nugren and Jo Hamel of the Defense Systems Management College. Without a session of PMC 89-3, neither the last 5 months nor writing this article would have been as rewarding or so enjoyable.

International defense acquisition is not new. There are few pieces of defense equipment in the inventory of the United States, or anywhere else, that are not dependent upon a component or raw material obtained on the international market. Factors associated with defense demands for raw materials have shaped international politics for centuries. In the current debate on dependency upon overseas suppliers, this truth frequently does not surface.

Examples of dependency on the international marketplace can be found in critical minerals. Columbium is an element used in superconductors and as a component alloy in hard steels. Demand for this vital commodity is rising at an annual rate of some 6 percent and is imported to the United States from Brazil, Canada and Thailand.[1]

Other minerals essential to defense include chromium, cobalt, manganese, platinum and tantalum; for these, it is estimated the United States has domestic reserves capable of meeting only one-tenth of its needs for years up to 2000.[2] The United States depends on countries as varied as Thailand, Brazil, the Soviet Union, the Philippines, the Republic of South Africa, and the United Kingdom. 3

Such dependencies are not changeable by *diktat*: they result from geological makeup of planet earth. The self-evident truth of global economy is well understood by statesmen and industry. Inward-focused responsibilities of program managers caring for *our* programs make it easy to lose sight of the fact that systems in our custody constantly need to be viewed in an international context from the start.

The need for an international dimension to all we do is not driven merely by a dependency on raw materials and components.

Affordability of Defense

In *Augustine's Laws*,[3] Norman Augustine, president and chief operating officer, Martin Marietta Corporation, considers the rising cost of weapon systems. In *Law Number XVI*, he concludes:

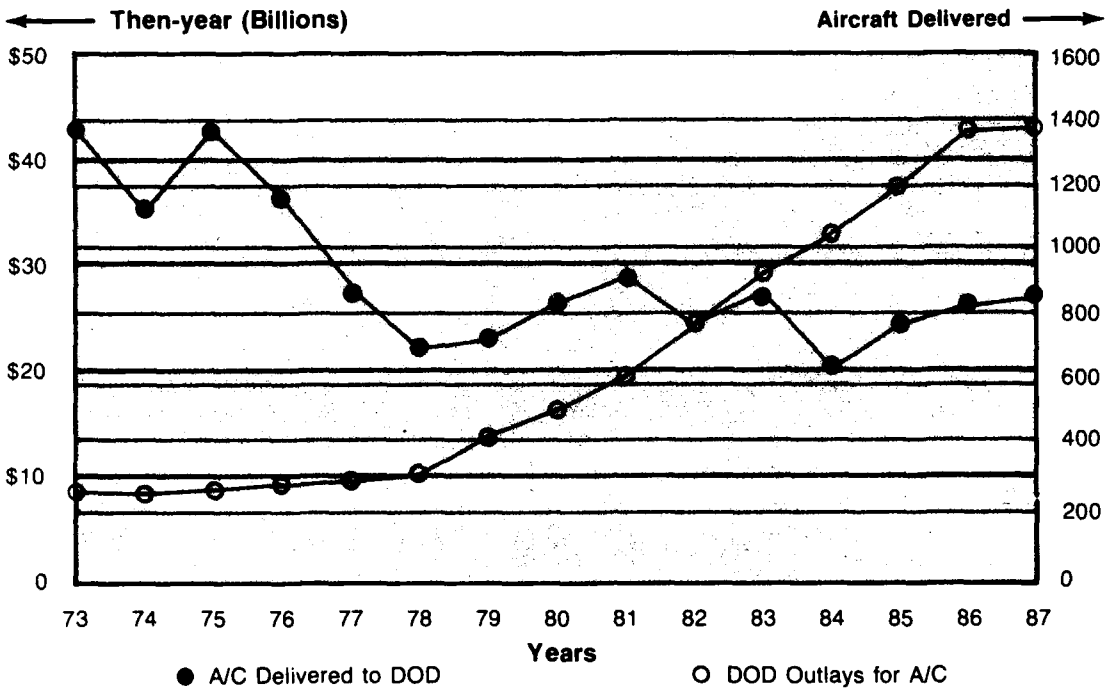
> In the year 2054, the entire defense budget [of the United States] will purchase just one aircraft. This aircraft will have to be shared by the Air Force and Navy 3 1/2 days each per week except for leap year, when it will be made available to the Marines for the extra day.

He analyzes the same effect in the United Kingdom and concludes that the Royal Navy and Royal Air Force will be reduced to sharing one aeroplane two years earlier!

While these predictions sound so far-fetched as to cause a smile, the comparison at Figure 1 of Department of Defense outlays, compared with aircraft delivered[4] between 1973 and 1987 shows how this can become a reality—particularly when a further annual $10 billion is added for aircraft research, development, test and evaluation.

Declining inventory of pieces of capital equipment is driven by their high costs compared with available resources, as well as the will of electorates and governments. Although increased capability can make up partly for a lack in numbers, it is unlikely to allow more than a short delaying action should there be a major conflict. There may be some truth in "He who has the most toys when he dies, wins." Gradual, non-deliberate reduction in the conventional defense capability of NATO has been called "structural disarmament" and assumes increased significance as the cheaper option of nuclear deterence is removed.

FIGURE 1. DOD OUTLAYS



The program manager can play a major part in delaying the onset of Augustine's 16th Law. By international collaboration—sharing the development burden, increasing the production run and ensuring the most economic logistic support—the program manager can reduce the life-cycle cost.

Of course, the program manager not only is driven by considerations of cost but by schedule, performance and supportability. Each will be discussed in an international context. First, there is advantage in considering positions of other players on the field.

The Big Picture

Without doubt, politics and industry are more significant than military need when matters of defense equipment acquisition are concerned, and rightly so. For program managers of NATO nations used to hearing from vested interests of middle-management of governments and industry, it is surprising to discover the underlying trend for years has been for *both* to support acquisition on an international scale. Nowhere is this more evident than in the United States where, to make good the havoc in Europe after World War II, the U.S. Government instituted Lend Lease, foreign military sales, coproduction and collaborative development. This trend in types of cooperative defense acquisition—from generous support to the sale of weapons made in the United States to a more equal partnership in the development and production of equipment—continues to be the policy of the United States and European members of NATO.

Initiatives of U.S. Government

In the early 1970s, the public policy for defense acquisition by the United States started to shift from the approach of the 1933 Buy America Act. In 1974, the Congress approved the Nunn Amendment that directed the Department of Defense to seek a greater degree of standardization and interoperability within NATO in the design, development and acquisition of weapons, and to make an annual report to the U.S. Congress. Reinforcement to this law came with legislation of 1975 and 1976, the former known as the Culver-Nunn Amendment. In 1982, a "Sense of Congress" resolution required the Department of Defense to reduce duplication and wasted resources in the NATO Alliance when acquiring weapons. The fiscal 1986 Defense Authorization Act included the Nunn-Roth-Warner and Quayle Amendments that provide the legal requirement and basis for collaborative development and testing of weapons. The Nunn Amendment is of direct relevance to program managers and I will discuss it subsequently. Most recently, the fiscal 1990 Defense Authorization Act codified objectives of the Nunn Amendment into Title 10 of the Armed Forces Code.

It would be less than honest to ignore congressional arguments seeking to counter international acquisition. For understandable reasons, these have tended to come from communities of interest centered on old industries that are in global recession, or from new technologies enduring a highly competitive youth. Protectionist sentiments may well have had a part to play in the unsuccessful Glenn "Science for America" or Traficant (5 percent surcharge for off-shore defense purchases) Amendments of 1986.

In addition to public law, the Department of Defense negotiated Memoranda of Understanding with 19 nations seeking to establish mutually beneficial bilateral trade in defense acquisition. It was from memoranda with European partners that the two-way street evolved.

Defense Industry

Defense industry finds itself both the two-way street and the vehicle on it. By governments encouraging defense industries to collaborate with Allies, and also seeking participation of foreign contractors, they strengthen international bonds and ensure purchases of their taxpayers benefit from the widest choice available. It is axiomatic that the prime requirement of industry in our capitalist societies is to make profits for investors who, usually, are more interested in short-term return than long-term investment. Of course they are not unpatriotic but *nimby* (not in my back yard) or rather *nimbp* (not in my back pocket) tends to prevail; the danger of structural disarmament, mentioned earlier, is not the main topic of conversation on the London Stock Exchange or Wall Street. Thus, there is an over-arching demand from within the defense industry to get out there and compete.

Western defense industry is undergoing major upheaval caused by international and domestic politics and by changes in world-trade patterns. As the public perception of a peaceful world increases, it is understandable that it will be less acceptable to spend, perhaps waste, resources on defense that would be employed better elsewhere. The market for defense systems is shrinking and causing a consequent reduction in profitability for defense contractors.

As a result, well-known names have turned their swords into plowshares. For others, defense is a way to keep in contact with the cutting edge of technology for subsequent use in commercial divisions rather than making serious money from defense business. Some, yet to diversify into commercial fields, are not finding defense profitable. For example, Northrop reported a $78 million loss in the second quarter of 1989 while McDonnell Douglas reported losses of $48 million.[5] Elsewhere, rationalization is occurring: General Electric Co. (U.K.) and Siemens (German) together purchased the British Plessey defense electronics conglomerate. In France, there has been a similar combining of assets, and U.S. Corporations have bridged the Atlantic by buying into European companies like SNECMA (French) and Westland (U.K.). It is likely the trend will continue in response to international defense market forces until the balance of supply and demand is readjusted.

In this volatile period, defense contractors may be better versed in foreign affairs than middle-ranking officials, military or civilian, of their own governments.

In this volatile period, defense contractors may be better versed in foreign affairs than middle-ranking officials, military or civilian, of their own governments. Contractors are used to the bargaining and bartering, resulting in devices like offset, local manufacture and buy-back. Contractors know they are integral and accepted parts of international trade.

Tension in the defense industry at this evolutionary stage has negative and positive impacts on achieving the program manager's goals. There is great competition for domestic and international sales. The reduction in Middle Eastern petro-dollar spending on weapons contributed to a 60 percent reduction in 4 years in "traditional" arms export markets at a time when non-traditional arms suppliers, like Brazil and Pakistan, have entered the competition. This international competition can be turned to the advantage of the taxpayer. However, if the program manager does not keep the international perspective in view, an embattled and, perhaps, vulnerable contractor can seek to shelter behind protectionism—potentially an expensive option for the same taxpayer and a corrosive influence on alliances.

A good example of the power of international competition, and collaboration, can be found in the bulk purchase of 155mm ammunition for a number of NATO armies (including the U.S. Army) by the NATO Maintenance and Supply Organization based in Luxembourg. The international competition for the supply of this ammunition was won by the contractor in the United States which had been supplying the U.S. Army. As a result of the collaborative purchase, the U.S. Army obtained 155mm ammunition 30 percent cheaper than earlier.

International Issues Vs. Domestic Politics

Domestic politics cause governments to seek to maximize national well being by increasing foreign trade. International influence also can be enhanced by careful use of acquisition collaboration as one limb of foreign policy. In his 1989 report for the National Defense University, Bob Calaway said:

> A government-wide policy for defense trade and armaments cooperation, supported by a presidential directive, would have made the "stand-off" on the FSX...[and other] kinds of public conflicts avoidable....
>
> High-level interagency working groups and steering committees are useful, but interagency communications between the grass roots government employees must be encouraged as well.[6]

Governments of Allies can cooperate in this; for example, in seeking to prevent proliferation of nuclear weapons.

However, armaments industries are competitors selling arms in the global marketplace: The competition among

vigorous marketeers can be a challenge for coordination between departments of one government, let alone among governments. Here lies a stress point of international defense acquisition—collaboration versus competition.

In an ideal world, *security* should not be an issue between Allies but, regrettably, it is. The pressure under which relatively junior but significant security officials operate is intense. With no knowledge of the big picture, they find it easier and less risky to consider no foreign disclosure (NOFORN), or the equivalent in other nations, the appropriate security classification caveat for matters which, if brought to the attention of the senior decision-maker, would be considered the raw material of collaboration. When common sense indicates, the program manager should challenge ill-informed views from advisors with a career-vested interest in making a personal specialty a high-profile topic.

Government and industrial factors, security and commercial advantage, come together in technology transfer. This is one kernel issue that might make enemies of friends. It is *necessary* that, as the ratio between resources available for defense and the cost of weapon systems become smaller, the Alliance maintains the tightest, affordable security.

It is *reasonable* that each sovereign nation in the Alliance should wish to prosper by having a positive balance of payments.

It is *understandable* that a defense contractor should wish to maintain a technological advantage over competitors.

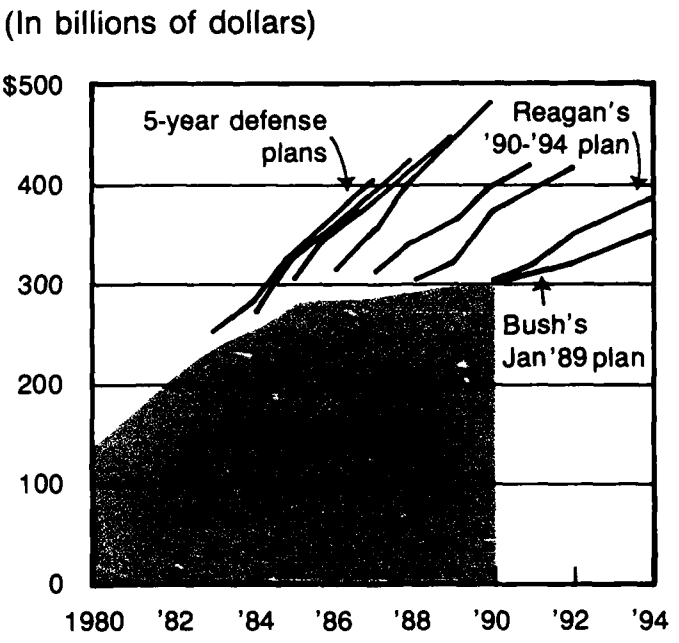
It is *essential* that the program manager understands how best to serve the taxpayer by balancing these different issues.

It is *likely* the program manager will *only* obtain valid guidance from offices with a broad view of government policies.

Advice

Conventional wisdom regarding collaboration versus competition is available to the program manager from the supporting laboratory and contractors.

FIGURE 2. PLANS VS. REALITY



Source: Department of Defense

On reflection, this advice frequently is well-meaning but flawed by career-vested interests of the giver, or by lack of access to policy intentions of senior government officials or corporate management. Good advice is available from departments created to give it; for example, the Ministry of Defence, London, Directorate of Procurement (International) is mirrored in the Department of Defense, Washington, by the Office of the Deputy Under Secretary of Defense (Industry and International Programs) and it is from here and from embassies' military staffs that first-hand information on relevant policies, laws and agreements may be obtained.

Military Need

The program manager is the center of attention and cost, schedule, performance and supportability are at his focus. Performance is measured by ability to meet the military need which, in turn, is derived from the threat statement. It might be reasonable to assume that for the NATO Alliance a common threat statement leads to a common military need; however, experience shows this a false assumption. The program manager has a part to play in improving operational effectiveness. Questions that should have been raised before the program manager became involved are: If other armies in the Alliance don't need this, why do we? If we need this new weapon system, can we collaborate in the derivation of a Mission Need Statement with other members of the Alliance? What systems are other Alliance members working on to meet this need, and can we collaborate? If we do this, are we contributing to structural disarmament? If they are not, self-delusion may set in as wishes outstrip available resources. An example can be seen from a comparison of the five year defense plan (FYDP) and appropriations between 1980 and 1990 at Figure 2.

When those questions have not led to a satisfactory answer, the program manager, and superiors, can pose them often. By taking a common approach, goals of rationalization, standardization and interoperability may be

What can a program manager do, via international collaboration, to achieve the most in an environment where his systems are becoming more expensive as available resources are reducing?

achieved. By collaborative research and development and production, weapons systems, otherwise unaffordable, may be contemplated. Indeed, if this approach is not taken, there is a danger that "the preservation of jobs is becoming the real goal of defense strategy"[8] and the taxpayer does not obtain the best, affordable defense.

Achieving a common Mission Needs Statement agreement with all or some Allies is not easy. There are genuinely different operational needs for nations having global roles compared with those envisaging operations only in one theater; at other times, the different phasing of finance and different concepts for operations in the same theater are obstacles to a common equipment approach. In the latter cases, there may be advantage in challenging the vigorously defended national operational position.

If compromise will result in defense that is affordable and represents the best value for money, it is worth pursuing in the wider NATO fora, or in the several senior-level bilateral discussions groups like the U.S. Army/British Army Staff Talks that seek to agree on common conceptual approaches to common problems.

Successful Programs

Collaboration in the acquisition of weapon systems is not easy for military services, government laboratories or defense contractors. The decreasing budget available to defense and the rising cost of weapons make it an increasingly attractive, perhaps essential, option. To consider successful and ongoing programs may dispel concerns in the minds of overcommitted program managers.

When viewed from the United States, probably the F-16 program with coproduction in Belgium, Denmark, the Netherlands, Norway and the United States stands out as the most successful, while the multinational Tornado Aircraft Program may seem outstanding to European eyes.

Others include the Milan Anti-Tank Guided Weapon and Jaguar aircraft. The major contrast between the different programs is that while the American F-16 was sold to the European Participating Governments by means of a coproduction agreement, the Tornado was jointly developed and constructed by France, Germany and the United Kingdom.

The other systems mentioned also fit the latter model. An approach which from the outset is collaborative would seem to auger best for the future of all nations in the Alliance. So far, it has not been possible to achieve this for apparently obvious candidates like the next-generation fighter aircraft for NATO.

Other successful transatlantic cooperative ventures include AWACS, Harrier GR5/AV8B, adjuncts to the Joint STARS program and the Multiple Launch Rocket System Phases I and III. There are others that have common threads of difficult but successful negotiations, a degree of subordination of military sovereignty in favor of value for available money, and an awareness of the global nature of high-tech industry. Such programs acknowledge that the industrial base of each allied nation has expanded to include, and is interdependent upon, the capability of all.

An Attitude Problem

The interdependence of Allies, for defense and for defense acquisition, is a truth that military and government officials not having exposure to the international scene find difficult to accept. In his report to OSD,[9] Thomas A. Callaghan, Jr., quotes a U.S. Air Force lieutenant colonel:

> You see, if some foreigner were to come into my office with something better than we have, I wouldn't buy it. I'd try to get a license, so we could get the technology and produce it here. And if I couldn't get a license, I'd start a development program so that the technology could become part of our industrial base.

This comment could have been made in many countries and it is in contrast to U.S. Government policy expressed by the Secretary and the Deputy Secretary of Defense. This is to gain the advantage of global technology by increasing its investment in cooperative defense acquisition programs "from the current 3 percent of RDT&E expenditures to 25 percent by the year 2000."[10] In his same report, Callaghan comments that the United States has a ...grand strategy [which] is collective and interdependent upon Allies [but a] national culture which is autarkic and independent of our Allies.

The dangerous illusion of independence, whether military, technological or economic, is not prevalent in the European members of the NATO Alliance, despite divergences of views existing among sovereign states of NATO on the other side of the Atlantic. While acquisition for defense has become an international business and an economic imperative for the taxpayer, government may not have procedures and adequately trained and experienced people in place to deal with it.

The Program Manager

What can a program manager do, via international collaboration, to achieve the most in an environment where his systems are becoming more expensive as available resources are reducing? There is no formula to be applied and the Defense Systems Management College phrase *it depends* is applicable.

Without doubt, the program manager should know government policy regarding collaboration. Knowing the requirement to gain the benefits, and cost reductions, of international RDT&E makes sense. By understanding provisions, funds and obligations of the Nunn Amendment, program managers of *all* NATO countries can cooperate to obtain more affordable, interoperable defense.

Perhaps the key attribute for the program manager is thinking beyond narrow domestic and engineering boundaries of *his* program and short testing period in the hot seat. International collaboration requires well-meaning and well-motivated practitioners with the necessary imagination to assemble packages allowing everyone to realize a win-win outcome. This takes time and patience. Perhaps the purchase of U.S. Patriot missiles by Germany, partly in return for the Bundeswehr (West German Army) securing U.S. Air Force bases in Germany, is a good example. It may be better to cajole the user community into compromising on requirements and collaboratively develop and produce a solution. Practical steps to take include establishing a well-thought-out and understood memorandum of understanding and achieving the best relations among collaborative program offices. Embassy staffs and the National Military Representative to NATO should play major facilitating roles.

Acquisition Environment

Some prerequisites for international collaborative success are beyond the terms of reference of the program manager. A political will is a *sine qua non*. At a bureaucratic level, things like harmonizing contractual procedures and requirements and reliable and swift communications are essential. After all, collaboration between sovereign states is not governed by the Federal Acquisition Regulations or the equivalent in other nations. An increasing globalization of defense industry, caused by the economic imperative of over-capacity, should be eased and channeled by Allied governments to ensure combined goals. Then, international collaboration by defense contractors should be encouraged and monitored but not micromanaged.

Perhaps the key to using internationalization and gaining the best value for the taxpayer is ensuring program managers and staffs obtain the best international education in our trade.

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Colonel M. Rex Stephenson, a graduate of PMC 89-3, was the first British officer to attend the Program Management Course at the Defense Systems Management College. Before that he served in Washington, D.C., as a liaison officer to the U.S. Army. Earlier assignments include service in Northern Ireland, Germany, the Netherlands, Zimbabwe and Ministry of Defence, London. Colonel Stephenson has returned to the United Kingdom to command the Army Tactical Telecommunications Agency.

The views expressed here are the author's and do not necessarily reflect those of the Air Force Institute of Technology, the Air University, the United States Air Force or the Department of Defense.

PRODUCTION READINESS REVIEWS:

CRITICAL ELEMENTS IN ACQUISITION

Captain Gregory A. Garrett, USAF

It is increasingly clear that a successful transition from the full-scale engineering and development (FSED) phase to the production phase is critical in the acquisition of a new major weapon system. We hear that Department of Defense major weapon systems face costly overruns because of poor product design, lack of producibility planning, too little preproduction testing, etc. These stories, not new and all too common, indicate that in the transition from full-scale engineering and development to production there are opportunities for costly mistakes and failures.

To resolve these problems, a Defense Sciences Board Task Force, formed and chaired by Dr. W. J. Willoughly, Jr., developed DOD Manual 4245.7 *Transition from Development to Production*, dated September 1985, and the follow-on NAVSO P-6071 *Best Practices* pamphlet, dated March 1986. These provide important information, in easy-to-understand formats called templates, to assist program managers in tough decision-making processes during the complex transition process.

However, these documents simply provide a general path to follow. Outlines and schedules for reducing risk and suggested best practices to avoid problems do not identify specific elements of risk or the magnitude of risk a program may face.

I contend the best tool available to a program manager for identifying risks involved in transitioning a major weapon system from development to production is a properly planned, staffed, and executed production readiness review (PRR).

A production readiness review is a formal incremental process examining and reporting in detail a contractor's readiness to transition a design to production. The production readiness review which evaluates and reports program risks in the vital transitioning process from full-scale engineering and development to production verifies that the design, planning, and preparations for a system enable a production commitment without incurring unacceptable risks to quality, cost, schedule or performance.

My focus in this article is an overview of program readiness reviews including planning PRRs—what, when, where and how; planning and staffing the PRR team; ten tips for conducting successful PRRs; and pros and cons.

What, When, Where and How

The PRR, usually a lengthy and formal incremental, time-phased process, is not intended to be a one-shot pass or fail, in-and-out government review. My experience shows that on most major weapon systems, two or more PRRs are conducted during FSED.

However, PRRs should be planned in detail as early as possible, usually during the demonstration and validation phase of a major system acquisition. This ensures sufficient planning time and resources are available during FSED to conduct the PRRs.

The exact timeframe for conducting PRRs varies upon the system and length of FSED phase; the first PRR should be within 90 days of the critical design review, and at least yearly thereafter.

The PRRs are conducted by government personnel on prime contractors, at the prime contractor's facilities. Prime contractors are responsible for conducting PRRs on their subcontractors, at the subcontractor's respective facilities, as established by the government.

Planning a successful PRR is not easy. The plan must be developed and approved by the sponsoring Department of Defense component before execution. The DOD Instruction 5000.38 *Production Readiness Reviews* provides a general outline of procedures to follow when developing a PRR plan. The DOD I 5000.38, suggests:

(1) Preliminary steps should be taken well in advance of the PRR to assure timely availability of the information to be evaluated. (2) The PRR will be planned to examine and report on the developer's design from the standpoint of completeness and producibility. (3) The PRR will also examine the producer's production planning documentation, existing and planned facilities, tooling and test equipment, manufacturing methods and controls, materials and manpower resources, production engineering, logistics, quality control and assurance provisions, production management organization, contract administration and subcontract management. (4) The PRR shall be planned to provide a report to the PM which will identify potential problem areas which constitute production cost or schedule risks. Each risk will be expressed in terms of its relative magnitude and potential consequences. A summary statement will be made by the PRR team director to the PM concerning the production readiness of the program. 10

Air Force Systems Command Regulation (AFSCR) 84-2 *Production Readiness Reviews* specifically says a PRR plan should include: PRR team's organization and each member's responsibilities; PRR's subject/program for review; criteria for tracking and measuring production readiness; format for documenting observations, discrepancies, and contractor corrective actions; schedule for completing the PRR, including a completion date.

If you follow guidance for planning PRRs in the applicable government instructions and regulations, use common sense, and get expert advice from people previously conducting PRRs, you should have a successful plan.

The PRR Team

Ideally, the PRR team comprises members independent of the host system program office (SPO) currently managing development of the system. Independent team members represent outside agencies like contract administration offices, laboratories, Service schools, other system program offices, consultants or higher headquarters. Due to myriad difficulties in obtaining people totally independent, most PRR teams include too many host SPO personnel.

Typically, the PRR team director is the host SPO director or deputy director of manufacturing and is responsible for staffing the team. The PRR is required to examine a broad range of functional disciplines as prescribed in the DOD 4245.7-M template categories. The PRR team director must find people with expertise to provide technical and management judgment in specific areas called for and they should be able to develop the plan for the PRR. Finding and obtaining personnel to conduct a successful PRR is not easy. Other observers, like product engineering services office personnel, attend PRRs to evaluate policy and transition strategy, or to develop a headquarters understanding of program status, risks and strengths. Remember that quantity of personnel does not compensate for a lack of quality personnel.

Ten Tips

Listed below are ten tips based on regulatory guidance and collective past experiences of myself and students participating in PRRs.

—Ensure close coordination of the PRR plan and daily agendas with the contract administration office representative and the contractor before and at the start of the PRR. Close coordination of the PRR plan among people helps to identify possible problems in scheduling interviews or other activities, which may result in necessary changes being made to the PRR plan and daily agendas.

—Caution PRR team members not to direct the contractor in any manner to make changes required in the contract. Only the contracting officer has the authority to direct changes in the contract.

—Stress hands-on and visual verification and evaluations by the PRR team rather than just attending contractor briefings.

—Organize the PRR team into panels or groups for each major functional area, led by an experienced PRR team member.

—Create a win/win PRR philosophy with the contractor by actively soliciting and obtaining maximum participation and cooperation from the contractor, primary source of information in this review process.

—Keep the PRR team size to as small as possible but maintain sufficient expertise.

—Maintain the same team members throughout reviews of specific areas and follow-up reviews to assess corrective actions, a vital part of a successful PRR.

—Establish simple but logical PRR formats to document observations, discrepancies, and contractor corrective actions, and ensure team members understand and can use the prescribed formats.

—Use the DOD 4245.7-M templates, DODI 5000.38, PRR supplemental regulations, and other criteria specifically developed for your program.

—Remind team members the primary purpose of the PRR is to gather information for the program manager. The PRR report is simply a risk assessment of the contractor's planned transition process from FSED to production.

These tips are common-sense steps that must be taken when conducting a multifunctional review of a contractor's facilities, personnel and production planning processes.

Pros and Cons

There are three primary *advantages* for conducting PRRs on a major weapon system:

—The PRRs provide a useful program risk assessment to the program manager, assist in determining whether a given contractor is adequately prepared to make transition from the FSED to the production phase without incurring unacceptable cost, schedule or quality problems.

—The contractor under review can gain much from the PRR, often discovering problem areas not previously identified and which had not prepared needed corrective action plans. The PRRs assist the contractor to avoid costly mistakes through in-depth multifunctional review of contractor plans and operations.

—Well planned, staffed and executed PRRs can save the American taxpayers money because the team identifies and assesses risks in this critical transition process, enabling the government and contractor toward better management.

There are three primary *disadvantages* for conducting PRRs on a major weapon system.

—If PRRs were not planned or staffed properly, subsequent PRR execution and information reported to the program manager may be erroneous. A poorly staffed team with little expertise may base evaluations on a contractor's promises and optimistic assumptions about the future; then, government and contractor receive a false picture of risks, inviting disaster during the transition. Conversely, a PRR team's overly pessimistic portrayal of contractor readiness to transition a system from FSED to production may result in schedule delays and excessive costs.

—The PRRs cost more to plan, prepare and conduct than they yield in cost savings/avoidance if the contractor is effectively managing the program.

—The PRRs may increase confrontational attitudes among groups because some government finding may expose risky areas threatening the contractor, opening a possible contention with the government.

Now, do you know *everything* that you *ever wanted* to know about PRRs but were afraid to ask? You can appreciate the complexity of what might initially appear as a simple review.

Clearly, it is incumbent upon the government to plan and execute credible reviews with qualified expertise.

It is incumbent upon the contractor to plan adequately for the transition process from FSED to production and to be prepared thoroughly for a government PRR.

Any program manager will tell you that every major weapon system preparing for the transition process from development to production has risks. Knowing risk areas can lead to a better understanding for everyone, focus management attention, and effect corrective action to weak areas before a production commitment.

This is the purpose of production readiness reviews.

Captain Garrett, USAF, CPCM, is an instructor of contracting and manufacturing management at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

PRODUCTION COMPETITION LESSONS LEARNED:

RECURRING PRODUCTION COSTS

David M. Hodulich
J. W. Drinnon

SGT Charles J. Kudlacz, Jr.

Careful economic analysis of production competition issues supports resolution of many acquisition planning questions, ranging from key strategy issues to contracting matters.

—What is the appropriate competition strategy for this program?

—How should technology transfer be accomplished?

—Who should perform source-selection tasks?

—When should program buy-out occur?

Much progress has been made in the recent years to provide support to program managers required to analyze these and other production-competition questions. Predicting costs and benefits of production competition is a controversial subject.

We feel it is *important* for program managers to understand the standard framework for doing competition analysis—to be a competent participant in studies and thereby have protection from shoddy analysis, leading to bad decisions, leading to enormous and unnecessary costs. Stakes are large in this area.

This article focuses on issues involved in predicting *recurring* production costs when competitive sources are established. Non-recurring, front-end costs of establishing productin competition will be discussed in a subsequent article.

Here, we discuss the DSMC competition model and its data base. We present lessons learned in analyzing competition questions in recent programs.

Predicting costs and benefits of production competition is a controversial subject.

Competition Evaluation Model and Its Data Base

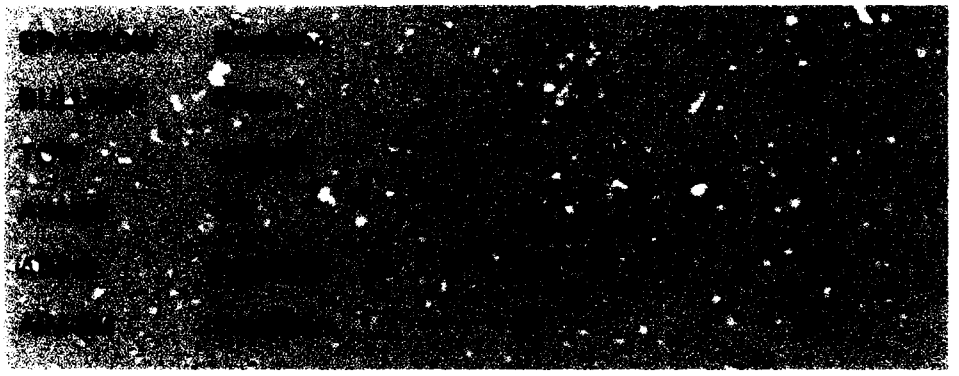
It is important for program managers to have a general understanding of the Competition Evaluation Model, its purposes, its limitations, and its data base.

The Competition Evaluation Model (CEM) was developed in 1979 for the Joint Cruise Missiles Project Office during a study to determine cost-effectiveness of competing production of the Air Launched Cruise Missile.[1] Subsequently, the model was described in the DSMC competition handbook.[2] In 1986, a PC version was developed for the DSMC Production Competition Course.

The PC version has been enhanced several times, thanks to the Navy Competition Advocate General, and is widely used throughout the Department of Defense and the defense industry.

*TABLE 1. OBSERVED SHIFTS AND ROTATIONS**

Program	Developer	(Shift Percent) (Downward)	(Rotation Percent) (Steepening)



* Sources: SPARROW, BULLPUP, TOW, and AIM-9B--*DSMC Production Competition Handbook*; AIM-9L and AIM-9M--*Navy Competition Handbook*.

*TABLE 2. SECOND-SOURCE BEHAVIOR**

Program	Progress Rate		Percent First Unit Cost Reduction
	First Source	Second Source	

* Sources: SPARROW, BULLPUP, TOW, and AIM-9B--*DSMC Production Competition Handbook*; AIM-9L, AIM-9M, and HELLFIRE--*Navy Competition Handbook*.

The CEM is a tool for decision-makers projecting into the future and trying to determine the economics of production competition. More narrowly, the model is a tool useful to planners evaluating alternative competition strategies. In summary, the model is:

—A mechanism for keeping track of many variables and assumptions

—An efficient calculator

—A mechanism for performing sensitivity analysis on the assumptions.

Limitations

The model is *not* a sophisticated tool for making precise statistical projections. It is not a scientific model and it lacks statistical precision. It is not a research tool. But, it is appropriate to its purpose: It forces people to do necessary research to develop intelligent inputs, to make explicit their assumptions, and it performs the arithmetic calculations efficiently.

Methodology

The CEM uses standard progress curve theory as a starting point for analysis. Its methodology assumes two changes can occur to an initial producer's progress curve when competition is introduced:

—The curve can *shift* downward, the result of the initial producer's price reduction when competition is established.

—The curve can steepen, or *rotate* downward, as the initial producer's prices continue to decline faster than they would have in a sole-source environment.[3]

The model balances these positive assumptions against expected costs of establishing production competition: front-end costs of technology transfer and production qualification; life-cycle logistics cost increases resulting from second sourcing; and progress curve-and-rate penalties caused by splitting production between two sources.

The model performs calculations on values entered by the user. It requires the user to enter parameter estimates such as the year competition will be introduced, expected first-unit costs and progress curve slopes for both sources, estimated recurring and non-recurring costs of establishing a second source estimated shifts and rotations, and the annual production split between the two producers. Using these inputs, the model calculates production costs for sole-source and competitive approaches. The model then permits breakeven and sensitivity analysis, showing results of changes in factors such as quantities to be produced, schedules, initial unit costs, and inflation and discount rates.

The CEM is entirely input driven—it is a calculator. Criticism concerning the model rightly should be directed toward users misusing the competition data base (discussed in the next section) when developing inputs. The point to be made here is that the Competition Evaluation Model is a handy tool for planners and decision-makers having to analyze competition questions.[4]

Handbook Data

Table 1 presents the generally accepted data base on the progress-curve effects demonstrated by sole-source producers when competitive production sources have been established.

Several points are important.

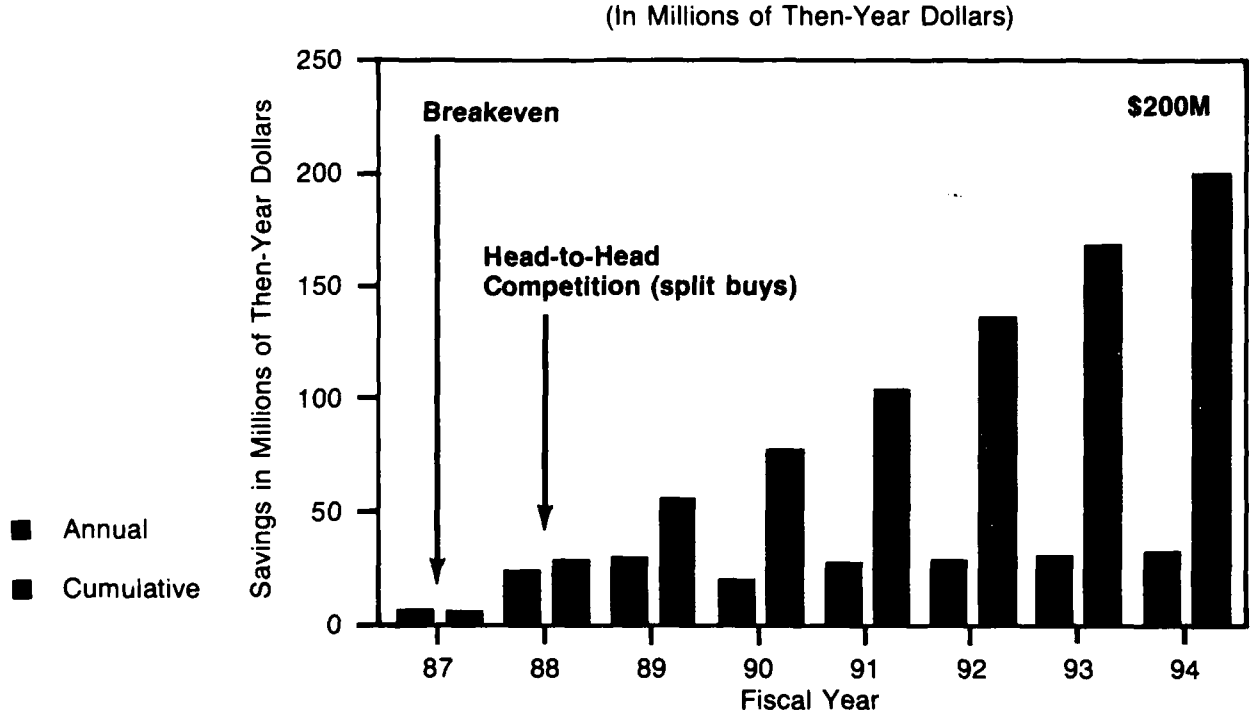
—The data on these five programs have been analyzed and reanalyzed extensively during the last 7-8 years. Statisticians do not agree on validity of figures shown on Tables 1 and 2.

—The small number of observations and their large variances indicate that use of average values would be inappropriate. Additionally, observations are from missile programs employing various technology transfer techniques at different points in the acquisition program, so use of average values in a current analysis would be worse than inappropriate.

—However, all the observations show progress curve effects beneficial to the government when competition is introduced.

Also, as displayed in the next section, Navy experience with production competition has shown, without exception, beneficial progress-curve effects when competition has been introduced.

FIGURE 1. ESTIMATED SAVINGS FROM STANDARD MISSILE-2 ROCKET MOTOR COMPETITION



Note: Breakeven year is before head-to-head competition begins due to ARC's very low bid for 130 rocket motors in FY87.

Pyatt Data

Assistant Secretary of the Navy Everett Pyatt released data on eight Navy competitions.[5] Figures 1, 2, and 3 concerning a Standard Missile component, typify his data and speak for themselves. Pyatt's data typify that released by Army and Air Force acquisition executives.

Beltramo Data

Dr. Michael Beltramo published results of an SAIC analysis of Navy data to determine the effect competition had on previously sole-source contractors' progress curves.[6]

In four of the six cases studied, Beltramo and his associates concluded that developer progress curves became *less* efficient when competition was introduced—compared to what the curves had been in the sole-source environment. Beltramo presented his surprising findings in a chart of plus-and-minus signs, without numerical support.

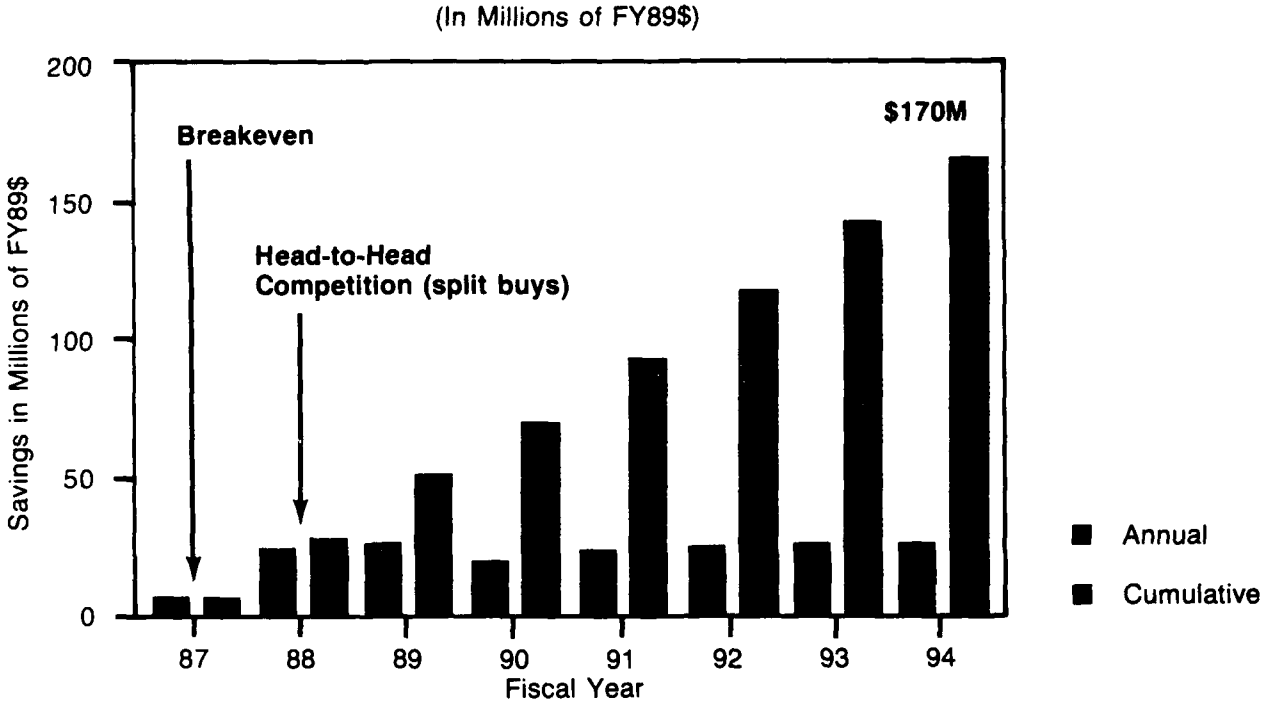
If developers' progress curves do flatten (i.e., become less efficient) when their monopolies are terminated, we have a very important lesson-learned for acquisition planners. We are confident, however, that Beltramo's findings do not withstand scrutiny.

We reviewed the SAIC analysis more than a year ago[7] to see if we could explain Beltramo's odd findings—particularly with regard to the SPARROW competition, where he concluded that the developer's curve flattened 2.3 percent when competition was introduced. We found, in brief, that their analysis was not performed using standard procedures applied consistently and that their quantitative irregularities always strongly favored the sole-source alternative. Across the board, their analysis was inconsistent internally, was inconsistent with the data, and was inconsistent with any systematic methodology.

Concerning SPARROW in particular, we used Beltramo's data and confirmed Louis Kratz's earlier conclusion that the developer had steepened his curve subsequent to the establishment of competitive production sources.[8] (We found a 4 percent downward rotation, as opposed to Kratz's 8 percent; we do not have access to Kratz's data, so we cannot explain the difference.)

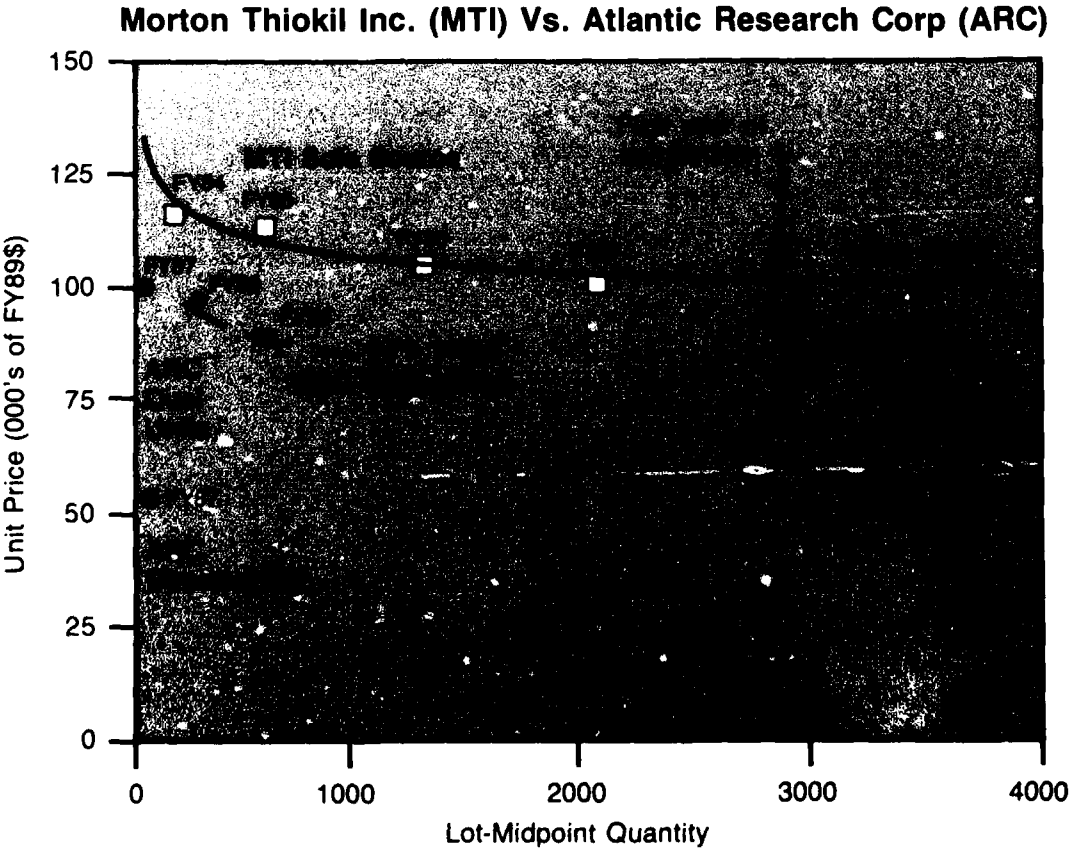
Secretary Pyatt's report, previously referenced, provides data considerably at odds with opinions expressed in Beltramo's *Cha, Cha, Cha!* article. Pyatt's charts illustrate an important point regarding competition studies: whether a competition saves money or not depends upon the net effect of *all* inputs to the equation. Thus, if a developer's curve shifts substantially, even a negative rotation can be offset. More importantly, Pyatt's charts show how aggressive pricing by a second source can compensate for any increased slothfulness that Beltramo might see in the first source when competition is introduced.

FIGURE 2. ESTIMATED SAVINGS FROM STANDARD MISSILE-2 ROCKET MOTOR COMPETITION



Note: Breakeven year is before head-to-head competition begins due to ARC's very low bid for 130 rocket motors in FY87.

FIGURE 3. STANDARD MISSILE-2 ROCKET MOTOR COMPETITION



Conclusions

The Competition Evaluation Model is happy to process inputs reflecting an analyst's view that a monopolist's progress curve flattens when competition is established—the CEM accepts either positive or negative shift and rotation inputs. Again, the model is a calculator (a tool) useful to planners and analysts.

Concerning the competition data base, we think it is clear the data will never be of size and quality to permit automated input to the CEM. Analysts will have to provide inputs based on their experience and their study of cost, schedule, and technical issues specific to the program under consideration. On the other hand, we think it is clear that data do support predictions of beneficial progress-curve effects when competition is established.

Lessons Learned

We have the following observations for program managers considering production competition.

Competitive production programs have repeatedly obtained competitive prices substantially *lower* than predicted by the cost studies presented during Acquisition Plan reviews. It appears these underestimates of the benefits of competitive production are caused by:

—Overestimating non-recurring (one-time, front-end) costs of establishing and starting up the second source

—Underestimating ability of previously sole-source contractors to reduce costs or prices dramatically

—Underestimating ability of new competitive contractors to make producibility improvements and otherwise manage production programs efficiently.

Accordingly, when economic analysis shows competitive production sources may not be cost-effective, skepticism on the part of the program manager would be appropriate.

Inaccurate economic analysis can lead to poor acquisition planning, obviously. Inflated program cost estimates can lead to inflated contract prices and inflated contractor costs. Contractors achieve the production inefficiencies demanded of them.

Program-specific Analysis Required

As indicated above, program managers must perform detailed, program-specific analysis to determine inputs appropriate to their competition studies. While the data base is inadequate to support statistically precise projections, the data base clearly indicates that contractor progress curves will be more efficient under competition than under sole-source conditions.

Acquisition planners sometimes assume they can calculate competition cost-benefit ratios without resorting to serious analysis. They *know* the production program is too far along to permit establishment of the second source, or they *know* non-recurring (front-end) costs are too large to allow a competition program to break even. We have seen careful and objective analyses results surprise managers assuming competition would not pay. Remember that these economic analyses generally underestimate competition's cost savings. Accordingly, program managers should require careful analysis of their competition questions via the Competition Evaluation Model, available on PC disk, with user's manual, from DSMC (current edition is Version VIIb).

Rate Issues Exaggerated

First arguments incumbents make when threatened with competition concern production rate. They argue:

—Unit prices will increase because they will produce fewer items.

—They ultimately will be forced to leave the market.[9]

Prices need not automatically rise because of reduced production rates. In a competitive environment, contractors are motivated to minimize adverse effects of changes in production rate. We are unaware of any competitive programs where splitting production between two sources had adverse effects.

We know no instance where previously sole-source contractors were forced to leave the market because annual production quantities were reduced. Not only do these companies manage to stay in business, other companies are eager to compete, fully aware of quantity limitations.

A Navy analysis concluded several years ago that a second source's minimum sustaining rate would be four units per month. Unfortunately, the program's sole-source incumbent was then producing only the "minimum sustaining rate," four units a month. Although the program manager was convinced industry would not be interested, he was directed to solicit second-source proposals.

Three firms submitted proposals (including substantial investment in their own qualification), and competition was established. In the end, despite dire predictions, both companies are in business, producing units at prices below the old, sole-source price curve.

No Cost Increase

Production competition, by itself, does not increase logistics costs. If systems produced by two contractors are identical down to the discard level, logistics costs are unaffected. However, if fielded systems are different above the discard level, spares, training, and maintenance costs will likely increase. The secret is to incorporate logistics considerations into competition planning at the outset.[10]

If there is intelligent planning, production competition can lead to decreased logistics support costs.

—Dual sources for spares will reduce spare-parts procurement costs.

—If quality is a source-selection factor for spare parts production awards, contractors will increase quality.

Consider Entire Program

When government managers perform economic analyses to assess feasibility of production competition, they often use only current official program data. Although the approach appears fair, it is not. Any analysis not considering foreign military sales, spares, training units, system variants, or benefits expected on derivative programs is flawed. It tilts results toward sole-source alternative.

This is not to say that program managers should use irrelevant data or soft projections. Rather, they should research and verify program plans to obtain good data that goes beyond current official program plans. Program managers need to state explicitly their assumptions and explain how they were obtained.

By researching program plans and making findings and assumptions public, government and industry decision-makers can make informed decisions concerning competition, investment, and long-term returns.

Sensitivity Analysis Required

Because of the subjective nature of many of the competition model's input parameters, it is necessary to test sensitivity of the output to variations in those parameters. For example, the analyst should determine the break-even quantities required before production competition pays and determine the second-source progress curve required for an economically justified competition program.

Market Tests Required

If the economic analysis, within bounds of a reasonable sensitivity analysis, indicates production competition is cost-effective, test the market. Program managers should solicit industry views and statements of interest, confident that defense contractors will come forward only if the programmatics indicate profit potential in a competitive environment.

FIGURE 4. TYPICAL PRIME VERSUS VENDOR DOLLAR ALLOCATION

Cost Element	Passed to Vendors	Retained by Prime	Total
Purchased Items	$ 57,257		$ 57,264
Component No. 1	10,082		10,082
Component No. 2	1,007		1,007
Component No. 3			
Burden on Purchased Items		$ 7,857	7,857
In-House Effort		107	107
Component Integration and Assembly		117	117
System Integration and Assembly		3,158	3,158
System Test and Evaluation		1,783	1,783
System and Project Management			
General and Administrative Costs		7,907	7,907
Fee		10,881	10,881
Cost of Money		498	498
Total	$ 68,328 (68.3%)	$ 31,678 (31.7%)	$100,001 (100%)

Primes

A current system in development will be produced sole source because it is said to be "already 85 percent competed" and that "gaining competitive leverage over another 15 percent would not be cost-effective." We were told that the system's three main subsystems were all dual-sourced and that of every dollar spent by the government, 85 percent was sent to subcontractors.

Detailed analysis, taking all price elements into consideration, showed that the "already competed" percentage was actually less than 85 percent of product price. As Figure 4 shows, the 85 percent turned out to be about 68 percent.

Take Care

Many program managers, frustrated with sole-source progress curves, have seen those curves improve when competition is established. Similarly, other program managers have observed the reverse: progress-curve deterioration when the forces of competition are removed.

Negative shifts (price increases) and negative rotations (flattened curves) usually should be included when analyzing effects of winner-take-all buyouts on program costs. Buyouts typically return a program to sole-source production. Threats, cajolery, and fixed-price options are inadequate against monopoly power.

Summary Observations

Predicting costs and benefits of production competition is a complicated business, but the analytical framework is established and easy to understand. The Competition Evaluation Model simplifies the arithmetic aspects of the analysis and helps the analyst organize assumptions and make them explicit.

For our corresponding discussion of the non-recurring costs of establishing competitive production sources, see a forthcoming article, "Production Competition Lessons Learned: Nonrecurring Costs," to be announced.

LESSONS LEARNED SUMMARY

Perform detailed, program-specific analysis using Competition Evaluation Model.

Be skeptical if analysis shows negative savings—scrutinize assumptions. It is easy to develop bogus assumptions that prejudice analysis against competitive production sources.

Beware of economic analysis torpedoes; e.g., big rate penalties, excessive front-end costs, trivial progress-curve improvements.

Do not confine analysis to current official program data.

Do not strive for a perfect point estimate of savings. Perform sensitivity analysis.

Test market if, within reasonable bounds, production competition appears cost-effective.

Endnotes

1. Drinnon, J. W., and J. R. Hiller, "Predicting the Costs and Benefits of Competitive production Sources," TASC Report 1511, December 1979.

2. *Establishing Competitive Production Sources--A Handbook for Program Managers*, Defense Systems Management College, August 1984.

3. The model will accept both positive and negative shift and rotation estimates. Thus, analysts can estimate the results of a sole-source contractor's raising prices and becoming more inefficient when his monopoly is destroyed. We deal with such possibilities later, when discussing Beltramo's opinions.

4. The DSMC *Production Competition Handbook*, note 2 preceding describes the CEM methodology in detail (Chapter 4). A condensed description is provided in *Competition Evaluation Model User's Guide--Version VII*, published by DSMC.

5. Assistant Secretary of the Navy (Shipbuilding and Logistics), "Results of Navy Competition," January 1989.

6. Beltramo, Dr. Michael N., "Shift and Rotate Cha, Cha, Cha!" *Program Manager*, March-April 1989.

7. Drinnon, J. W., and John R. Hiller, *Review of Naval Center for Cost Analysis Report Entitled*, "The Effect of Competition on Procurement Price," LDI, Incorporated, June 1988.

8. Kratz, Louis A., et al., "Analysis of AMRAAM Acquisition Alternatives," TASC Report 4049, May 1982.

9. For discussion of these and other sole-source arguments, see "Production Competition Lessons Learned: Incumbent Contractor Torpedoes," *Program Manager*, May-June 1989.

10. For a discussion of logistics issues relating to competition, see "Production Competition Lessons Learned: Logistics Issues," J. W. Drinnon and D. M. Hodulich, October 1989.

Mr. Hodulich is a director and Mr. Drinnon the president of LDI, Incorporated.

IMPACT OF CLOSING AND REOPENING A PRODUCTION LINE

Mrinal K. Mukherjee, P.E.
Richard J. Baker

The study by the Congressional Budget Office[1] revealed nearly 50 percent of defense weapon systems are produced below minimum economic production rate. Economic production rate is defined as the rate offering an acceptable rate of return on the investment in production facilities. We produce below economic production rates mainly because our weapon systems require continuous product improvements due to changing technological and performance requirements, and budgetary constraints. When facing these major changes or severe budget cuts, there are available options.

—Producing the system at minimum sustaining production rate.

—Closing the production line and reopening to produce at an accelerated production rate, with or without changing requirements.

The minimum sustaining production rate is defined as the lowest production rate that, in the judgment of program managers, can reasonably sustain an active production base. In some cases, this is set according to the minimum feasible rate of production for one shift of workers employed 5 days a week. The first option of producing at a minimum sustaining rate is often chosen in preference to the second option of shutting down the production line altogether, since the first option requires little disruption of production facilities in terms of manpower, equipments, and toolings. There is a cost penalty for producing at well below economic production rate.

The second option can cause disruption of production facilities. Closing production lines means discontinuing production of subassemblies and final assembly. Manufacturing component parts may continue, during the interruption period, if there is demand for spare parts. This option creates enormous burden to management due to the difficulties in phasing out and ramping up production but it is argued that there is economic advantage to produce at an accelerated rate after reopening the production line with stable design and manufacturing processes.

Our twofold purpose in this paper is to examine effects of the second option (closing production line) on production resource, manpower, vendors, production equipment and production cost; and to present a quantitative approach to analyze the economic advantage, if any, for accelerated rate after production interruption.

Effects of Production Interruption

Manpower. The production related personnel will require reassessment. For a single-product manufacturing facility, laying off and rehiring will have to be considered. For a multiproduct manufacturing facility, the potential for transferring the production personnel exists if there are workloads available for other product lines. Need for retraining may be expected if there are significant changes in the manufacturing process when production restarts.

Vendors/Subcontractors. Some vendors/subcontractors procurement agreement will have to be changed or terminated. For vendors dealing with multiproduct lines, impact may be less severe compared to those with a single product line. Subcontractors/vendors have to be identified and contracting will have to be initiated before production restart.

Production Equipment. Production equipment, tooling, fixtures and benches have to be retained or moved to storage. Spaces have to be reallocated if and when production starts. Production equipments have to be acquired, moved and installed depending on process changes.

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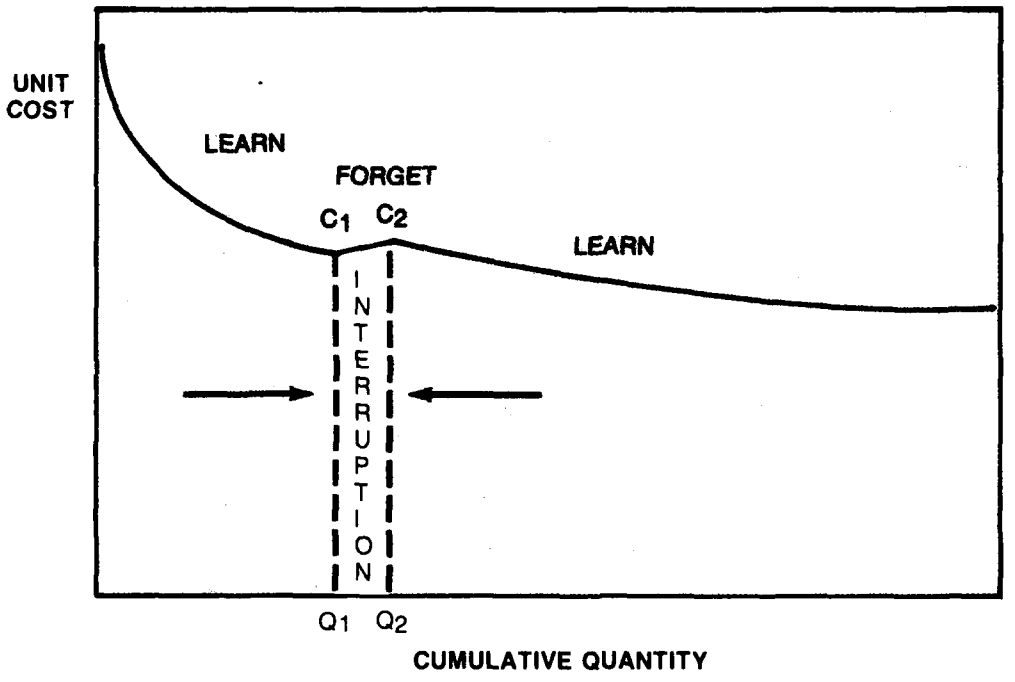
FIGURE 1. EFFECTS OF A PRODUCTION BREAK ON UNIT COST



Production Cost. Major categories of cost need to be considered.

—For maintaining facilities, production equipment, tooling, and fixtures or cost for relocating equipment and reinstalling when production starts, depending on the situation

—For transferring or laying off and rehire of production personnel

—For maintenance engineering and manufacturing personnel during interruption

—For "forgetting" or negative learning due production break.

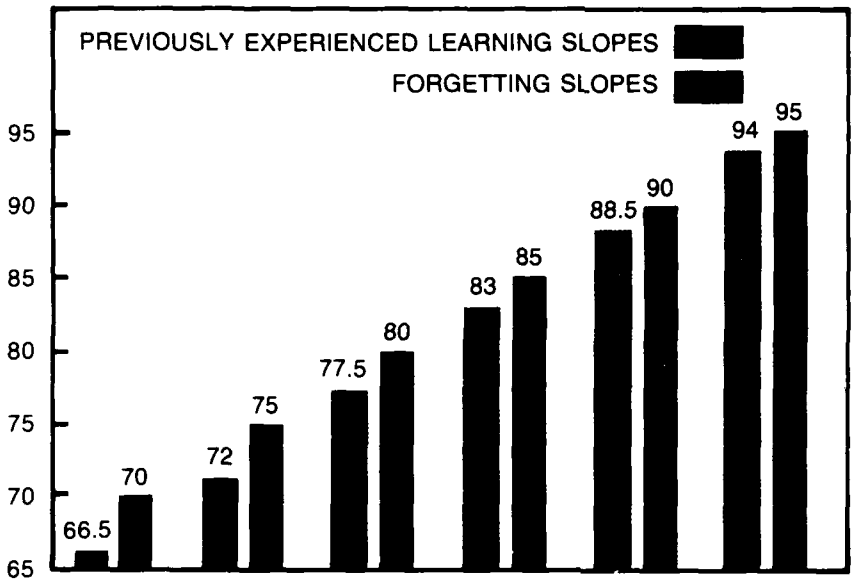
Estimation of the first three categories are straightforward, requiring no major assumptions. As to "forgetting," studies and experiments have been done. One aproach to estimate cost of "forgetting," proposed by Gilbride,[2] is to first assume equivalent units that could have been produced during production interruption period and estimate the "forgetting" slope to compute the unit cost increase from C_1 at the point of production break (Figure 1) to C_2 at the end of interruption period (converted to equivalent cumulative quantity). Gilbride found the forgetting slopes are steeper for previously experienced learning slopes and flatter for previously experienced reduced/flat learning slopes. Gilbride experienced the following relationships between forgetting and previously experienced learning slopes, as seen in Figure 2.

Economy of Higher Production Rates

The economy of higher production rate stems mainly from redistribution of indirect charges. The overhead costs are spread over larger quantities of production items; examples include depreciation of plant equipments and toolings, insurance, rent, security and utilities. Quantity discounts on purchase of parts and components are attributable to economy of higher production rates.

Several studies proposed methodologies to estimate cost sensitivity of production rates. The Bemis Study[3] proposed in a model that the unit cost is a function of cumulative quantity and production rate. Bemis model parameters include the Theoretical First Unit

FIGURE 2. FORGETTING SLOPES VS. PREVIOUSLY EXPERIENCED LEARNING SLOPES



Cost (A), the Cost Quantity Slope exponent, b_1, and the Cost-Rate Slope exponent, b_2. The model equation is as follows:

$$C = AQ^{b1} R^{b2}$$

where

C = Unit cost at cumulative quantity Q and Production rate R

A = Theoretical first unit cost

b_1 and b_2 are cost-quantity and cost-rate exponents.

The rate exponent in the equation is the indicator of cost sensitivity of the production rate. Bemis proposed three methods for establishing the cost-rate slope.

—Obtain pricing data over a range of production rates and fit values to an exponential curve as is done with the experience curve.

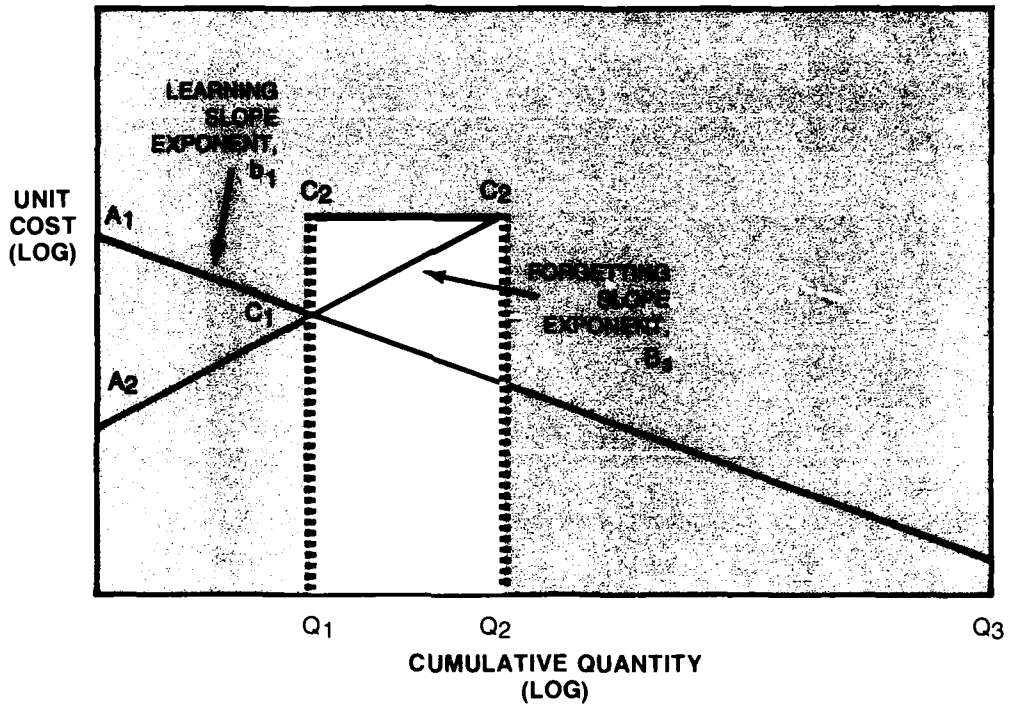
—Separate fixed and variable components of cost to redistribute fixed costs over more or fewer units during the annual time period. This will establish unit production costs at different production rates, and the rate slope can be derived from these individual values.

—Obtain cost data over a range of cumulative quantities and annual production rates, and establish three-dimensional response surface equation by using multiple regression techniques.

Interruption Vs. Minimum Sustaining Rate

To perform trade-off analysis for an accelerated production rate with interruption versus minimum sustaining rate without interruption, it will be essential at the outset to assess feasibility of production interruption. There are major questions to be considered. Can DOD afford to cease delivery of that system? Is management willing to take the burden of socioeconomic impact of production interruption? Is there enough payoff for such decision? The feasibility of production interruption depends mainly on management's ability to overcome the socioeconomic impact of a production break, efficient planning to phase out and phase in the production resources, and ability to ramp up the production rate after restart.

FIGURE 3. UNIT COST INCREASE DUE TO INTERRUPTION OF PRODUCTION



Estimating Cost of Interruption

As stated, the major cost categories for production interruption are cost of manufacturing/relocating production equipment, tooling, fixtures, cost of transferring/laying off and rehiring the production employees and cost of maintaining manufacturing engineering and manufacturing personnel; and cost of "forgetting." The first cost category (C_F) can be estimated by breaking down the tasks/cost and then estimating each subtask/cost element.

One approach of estimating the cost of "forgetting" is to use the negative learning curve theory where the unit cost rises as the interruption period (or equivalent cumulative quantity) increases. The increased cost due to interruption can be attributed to lower performance level by the production employees at the point of restart. This phenomena is depicted in Figure 3.

Derivation of the formulae for the cost, C_2, in Figure 3 are as follows:

Let

A_1 = Theoretical First Unit Cost prior to interruption

b_1 = Learning Slope exponent prior to interruption

b_2 = Rate Slope exponent for Production Rate, R_1, prior to interruption

b_3 = Forgetting Slope

Q_1 = Cumulative Quantity produced prior to interruption

Q_2 = Equivalent Cumulative Quantity that could have been produced during interruption.

Using the cost model for both cumulative quantity and production rate, the unit cost before interruption is:

$$C_1 = A_1 Q_1^{b_1} R_1^{b_2} \qquad \text{----(1)}$$

The unit cost after interruption is:

$$C_2 = A_2 Q_2^{b_3} R_1^{b_2} \qquad \text{----(2)}$$

(assuming the same production rate R_1, that would exist during interruption and the same rate slope, b2), also,

$$C_1 = A_2 Q_1^{b_3} R_1^{b_2} = A_1 Q_1^{b_1} R_1^{b_2}$$

$$\therefore A_2 = A_1 Q_1^{b_1} / Q_1^{b_3}$$

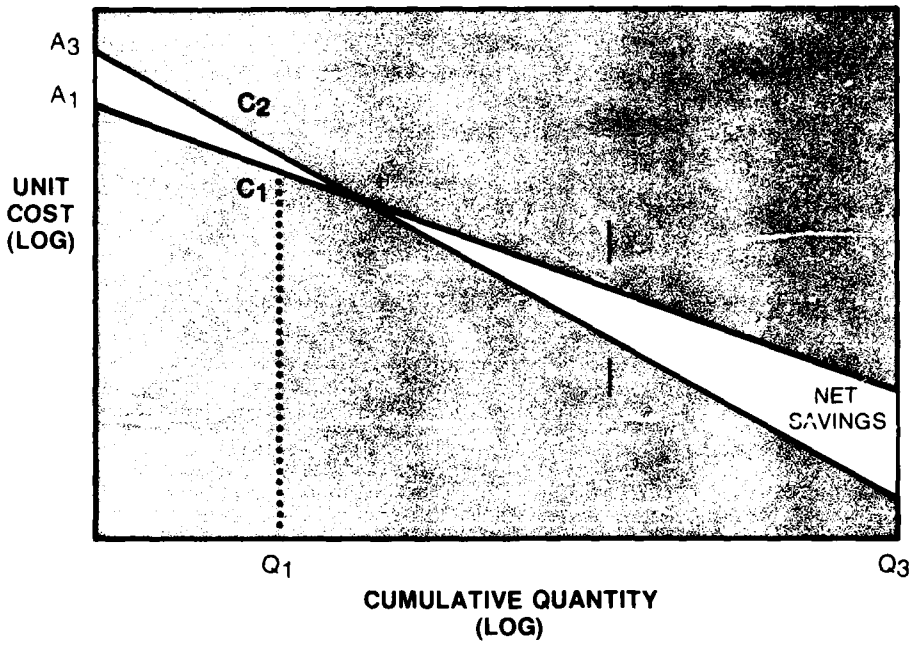
$$A_2 = A_1 Q_1^{b_1 - b_3} \qquad \text{----(3)}$$

Therefore, from (2) and (3)

$$C_2 = A_1 Q_1^{b_1 - b_3} Q_2^{b_3} R_1^{b_2} \qquad \text{----(4)}$$

Therefore, the net unit cost increase due to forgetting = $(C_2 - C_1)$

FIGURE 4. SAVINGS DUE TO AN ACCELERATED PRODUCTION RATE AFTER INTERRUPTION



Now the total cost for the accelerated production rate, R_2, for the program quantity, Q_3, with interruption will include total cost of interruption, and total cost of accelerated production rate, R_2.

Using the formula for computing total cost from learning curve theory, the total cost,

$$TC_2 = C_F + A_3 \left[\frac{(Q_3+.5)^{1+b_1} - (Q_1+.5)^{1+b_1}}{1+b_1}\right] R_2^{b_2}$$

where C_F is the cost of production interruption and A_3 is the increased theoretical first unit cost associated with unit cost, C_2 for cumulative quantity, Q_1 and slope exponents, b_1 and b_2 (see Figure 4).

Cost Without Interruption

Total cost TC_2 for minimum sustaining rate R_1, is calculated as from the Learning Curve theory:

$$TC_2 = A_1 \left[\frac{(Q_3+.5)^{1+b_1} - (Q_1+.5)^{1+b_1}}{1+b_1}\right] R_1^{b_2} \quad ----(5)$$

Therefore, the Net Savings/Loss (see Figure 4) for an interrupted production decision is given by:

$$\text{Net Savings/Loss} = TC_1 - TC_2 \quad ----(6)$$

Conclusion

Closing and reopening a production line appears to be a least desirable alternative. Department of Defense acquisition managers and defense hardware manufacturers have valid reasons for reluctance to implement such an option. In commercial sectors, this alternative is used during the change of model for automobiles or other goods. Plant closings are for brief periods to minimize the impact. In the multiproduct production environment and with a requirement for accelerated procurement schedule after restart, evaluation of such an option should be considered.

Undoubtedly, economic advantages can be derived from a stable design and an accelerated production rate even with a production interruption.

Endnotes

1. Congressional Budget Office, "Effects of Weapons Procurement Stretch-Outs on Costs and Schedule," November 1987.

2. Bemis, John C., "Design-to-Cost Under Changing Program Conditions," March 1985.

3. Gilbride, Thomas J., "Learning Curve Adjustment Due to a Break in Production," September 1984.

SEARCHING FOR LOGISTIC EXCELLENCE

Robert G. Olear

New, or newly modified, systems are acquired by companies and government agencies in increasing numbers and at frighteningly increasing costs. Some live up to or exceed requirements placed on the program manager. Many bury the manager's career. Herein, *system* is defined as anything that creates new, or greatly enhances, current mission performance. *Mission* is the primary objective of the organization.

For corporations, that would include any major addition to processing or production capability. For the Department of Defense, *system* usually refers to hardware and software acquired to counter a discrete threat or to increase unit performance. *Fielded* will denote an installed system that has achieved initial operating certification.

While there are differences in industry and government system acquisitions, the similarities outweigh them. Both are complex, expensive and capable of damaging an organization if mismanaged. Most people think of factories when considering corporate system acquisitions; i.e., new construction of buildings and tooling or retooling for new models. Yet, the expansion of, say, a chain of grocery stores also fits. Building or purchasing another store meets all requirements of our developing definition, adding mission capacity. It is expensive and deserves attention of dedicated people. Marketing considerations are complex and performance goals should be clearly stated.

As for the government, think of a system and you probably visualize aircraft, ships and tanks. Acquisition is complex and the cost and security risks of failure are great, so that whole classes of management tools, like PERT, have been created to field them properly. Huge bureaucracies have grown to plan, engineer, contract for, support and maintain them. Years, perhaps decades, are needed to field them completely. At the same time, lesser acquisitions are often held in disdain and, frequently, relegated to untrained people. The professionals seldom touch them, or only briefly, because the numbers are not career-enhancing. Good examples include communications gear, classes of computers, and minor upgrades to aircraft, ships and tanks.

These, typify the subject I will discuss. Although my terminology is associated with the government, and in particular the Department of Defense, consider each concept interchangeable among organizations and applicable to any system acquisition you analyze. If your organization uses better or different terms you feel comfortable with, use them. It matters only that we agree on meaning, and its significance to our organization.

This article should help measure your orqanization's health; show how failed acquisitions can bury careers; analyze a major reason why fielded systems fail; suggest how to avoid the path to failure; and offer no-nonsense rules to help your career live long and prosper.

I do not intend to offend any set or subset of managers in any organization but I pull no punches. Good managers will recognize opportunities for improvement; others will continue to search for someone else to blame.

What Kind Of Place Do You Work In?

If your job is to acquire and install new or newly modified systems, take a good and honest look at your organization. Think big and don't limit the look to your department or division. Count the people doing what you do. Think about the significance of that number for your career.

Look again—closely. Do bleached bones of good managers litter the floors? Is this a program manager's burial ground? Do you see peers being promoted beyond programs you know should have gotten them fired? Think about why you are willing to work in such conditions.

Or, is your organization one that values integrity, hard work and perseverance? Is there an attitude of teamwork, where people support each other's efforts for the good of the whole? Do you feel good when a peer gets a well-deserved promotion? Are you and peers in demand and competed for by other divisions or departments? What would it take to get you to leave?

An Organizational Health Math Test

You are ready to take the following test, designed to measure health of the entire organization, not your portion of it. Continue to think big. Total the systems fielded in the last 5 years; if nobody knows or if records haven't been kept beyond the last year or two, stop. The test is over. If you haven't cared enough to track important system acquisitions, your organization is sick.

If data are available, project the systems to be fielded in the next 5 years. This is your data base. Of the fielded systems, count those failing to meet minimal technical requirements, in any category, as originally defined. Add those running 20 or more percent above the original operating budget. Add those fielded 6 months or more late. Record the total. Is the number higher or lower than expected?

Review that count. How many have high system downtime in any subsystem or building or department due to lack of anything—parts, trained people, quality, good design? Measure *high* in terms of original technical requirements. Give yourself one point for each system on your list fielded 2 or more years ago; three points if fielded within the last year. If downtime is being induced by an element without a defined goal in the original contract requirements list, count each one 10. Add resulting points to the previous total.

Talk to peers if you have not done so recently. Of systems currently in the pipeline, how many are in trouble? Give yourself four points for each. Investigate further to determine peers put out to pasture in the last 3 years for failed system acquisition. Count each of those five. That ends work on the first list. Total results.

Begin a second list. Add senior managers in the acquisition business in your organization. This is your second data base. For each program manager terminated as per the first list, count senior managers in the chain equally accountable for failure of a given system. Give yourself 10 points for each senior manager who should have been fired, but wasn't. Be honest, not petty or vindictive.

Interpreting the Test

What is the purpose of this math exercise? It is for anyone wanting to make system acquisition a career and wanting to take pride in that career while enjoying it. It will be a warning to some, a chance at organizational redemption for others and, in a focused way, provides a measure of your organization's professional health.

Numbers represent my arbitrary values. Apply your professional judgment so that the numbers have meaning in the context of *your* organization. It is a weak manager who lets only numbers make his decisions.

Look at yourself. Were you aware of the fielded performance of systems—yours and others? Did you have trouble finding anyone who knew? Have you cared what happened to a system after you moved on? Did you follow it or try to help it in any way? Are you comfortable with these answers?

Look at your figures. If the total on either list is 10 or more and you are a good program manager, think about finding another place to work. Why? Because of the high probability of your early career burial or unhappiness. An organization continually failing at system acquisition is terminally ill. The place where you work is dying. If you don't have the authority to change what's wrong, bail out. If totals were less than 10, congratulations; Read on to ensure your organization stays healthy.

Now, for senior executives reading this: What are your scores? If less than 10, congratulations. Read on. If 10 or more, consider your next step. If you don't want to look out to see a sky full of parachutes, do two things immediately; Be sure your program managers don't read this for at least 5 years; take a closer look at your organization. Can you live with the

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scores? If so, there's little point in reading further. If not, what are you going to do? Unless you pop your parachute soon, you must ask why things are the way they are and develop tough cures.

Why Fielded Systems Fail

If your score(s) were too high and you want to turn things around start with why your fielded systems are failing. Reasons why acquisitions fail include lack of good planning, picking wrong people for the job, lack of a sufficient budget. A look at the history of organization failures should give you more. Fix them.

We will concentrate on a poor logistic infrastructure because it is not good enough to bring a system in on time and within budget. Lack of adequate and sustaining logistic support after fielding will strangle a system no matter what you do right. Take a look at what logistic support is and how it can go wrong.

What Is Logistic Support?

Logistic support encompasses various requirements, some compatible and others fighting to be divorced. These include operations, maintenance, supply, transportation, sustaining engineering, contract administration and quality assurance.

Operations refers to people and equipment necessary to use or run a system.

Maintenance is repair or service action needed to keep a system's hardware and software operating.

Supply encompasses purchasing, warehousing and issuing materiel used by operators or maintainers.

Transportation moves that materiel from vendor to user or from one operating location within the organization to another.

Sustaining Engineering includes technical design or redesign effort required to keep the system operating in the face of changes to the configuration of component parts. It does not include addition of new capabilities to an existing system.

Contract Administration refers to all continuing efforts to monitor compliance with contractual provisions after award. This includes the original contract for system acquisition, subsequent contracts for additional quantities of the system, and any follow-on contract to operate or maintain the system by outside sources.

Quality Assurance is everything your organization does to validate efforts of the vendor(s) of these contracts. This includes two important concepts; assurance that your organization receives everything it pays for, and assurance that it pays for no more than it receives.

Impact Of Poor Logistic Infrastructure

Why does a poor logistic infrastructure take a system down with it? If you accept definitions used here, the answer is obvious. No system can long survive without operators or maintainers. No maintainer or operator can function for long without materiel to keep the system going. Materiel does not appear miraculously. It takes considerable planning, people and equipment to produce it. It must be in the right quantity, at the right price, of the right quality, and always on time.

It must be used properly. Depending on size, complexity and criticality of a system, we may contract for some or all logistic functions. This implies ongoing surveillance effort to prevent, or detect and correct, any and all contractual deviations.

The system must breathe. There must be room to accommodate for obsolescence and poor design of any given system part. Things become unavailable, inadequacies become apparent. Sustaining engineers take care of problems, provided the right data were obtained at the time of fielding.

Adequate technical data, critical to the acquisition life cycle, are often the first thing to be traded away. Without data, design and sub-system compatibilities cannot be evaluated or altered, operators don't know how to start the system or keep it going, maintainers don't know how to fix things that break, supply people don't know what to buy, and purchasers must take any price offered for that materiel.

Restrict the ability of suppliers to do their jobs, and down goes the system. Do that often enough, and any system will be down for the count.

Need for Logistic Control

For our purposes, it doesn't matter whether operators and maintainers are in-house people or contractor employees. The result is the same. It doesn't matter whether the supply and transportation effort is contracted out totally or partially. What matters is the controls *your* organization places on efforts of people involved in operations, maintenance supply and transportation. Unless *you* take charge, any direction your system chooses to take, including straight down, is okay.

This is why it is seldom a good idea to contract out sustaining engineering, and why it is impossible to do so for contract administration and quality assurance. These efforts are woven into the control fabric. They are what we do either to regulate technical capabilities of the system or the performance of vendors of any sort. Abdicate on them and you abdicate on everything.

Why Logistic Support Fails

Why, then, does a logistic infrastructure fail? Besides loss of post-acquisition contract control we discussed, it dies for lack of good people or sufficient money. No organization's budget is infinitely elastic and there is seldom enough money to satisfy non-programmed requirements, taking us back to the need for good pre-contract planning. That is part of the picture. Unexpected economic setbacks can and will happen, causing budget shrinkages and realignments throughout the extended organization.

Other reasons for failure are poorly defined technical requirements, inadequate materiel pipelines, partial or poor data, incompletely trained

operators or maintainers, and quality assurance evaluators or contract administrators observing vendor performance poorly or infrequently. These can occur in moderately healthy organizations.

Sadly, an infrastructure fails before the system is fielded. This is because a manager decides, before award of the system acquisition contract, that it isn't important; that is, in a budget crunch, when faced with a decision to buy an infrastructure or more of a system, the manager opts for more system.

There's career glamour in this if you work in an organization with poor professional health, emphasizing *now* rather than *later*, *us* versus *them*. The messages such values transmit to program managers are clear: buy many systems or greater quantities of currently fielded systems—these get the boss' attention. Cut corners as needed to stay within budget. Eliminate the frivolous. Retain the necessary (things that make us look good). Don't consult functional experts when negotiating their portions away—that would display weakness. If push comes to shove, transfer from your current budget anything that will show up only on someone else's future budget.

Following such a pattern in a sick organization will get you promotions, more money, and an office with a view. It can propel you to the top. You will get these, that is, if you are fast enough to move up before the system goes down.

How Not to Fail—Program Managers

On the other hand, you may prefer to work in a professionally healthy organization. If so, you must not forget the characteristics of the unhealthy. Knowing the wrong way to do a job is sometimes as important as knowing the right way, if your aim is to succeed. If you want to field systems on time, at budget and working fine, remember the reasons for failure. Plan to avoid them.

If being a winner is important to you, acquire winners every time. This is what you get paid to do. This means don't ever ever take chances on the future reliability of any system. Manage your programs for the long-haul, as if your career depends on it. In the healthy organization, it does!

Determine your organization's mission. Know the purpose for existence of your organization and your role within it. For each system acquisition you manage, know its mission. What problem is it intended to fix? What exciting, new result is it expected to achieve? Remember the system's mission must support the larger organizational mission. Fight to make your system a winner but never at the expense of another system because every system is essential to achieving the organizational mission. Never scrimp on the logistic support structure because no system can run long or well without it. This is *never* the place to cut budgetary corners. Buy fewer systems, and make them winners, rather than chance losing mission accomplishment. That is true of for-profit corporations and for those defending their country. There is no second chance when the competition calls your bluff.

How Not to Fail—Senior Executives

If you are a senior executive, look at how you promote and reward program managers and support people. In a large organization, it is likely you have separate divisions for each, with separate career paths. Are the results of each linked? Do you reward program managers based on numbers—of systems fielded, dollars spent, quantities bought? Do you punish support managers for dollars consumed?

It's easy for a program manager to shave acquisition costs by trading down quality, reliability, durability, maintainability or supportability. A maintenance manager can improve this year's bottom-line by cutting back on preventive services and parking redundant machines that are broken. The support manager eventually gets fired because of escalating costs and downtimes but the bill stops ultimately with *you*.

Manage your programs for the long-haul, as if your career depends on it. In the healthy organization, it does!

Ten No-Nonsense Rules For Survival

Anticipate failures. Kill them before they kill you.

Embrace the mission a system is being acquired for. Make it your own.

Remember there is no way to get there cheaply from anywhere. Avoid economic shortcuts.

Accept the fact that other systems will compete for any budget. Be prepared to justify and rejustify everything.

Plan well but be willing to change plans when necessary. *Flexibility* wins.

Reward in ways that make sense for the organization mission. Condition everything on performance—and mean it.

Take charge, early and firmly. Run the logistic infrastructure or get run out of town.

Take the math test periodically. Know the state of your organization's health.

As a senior executive, don't wait for results of the math test. You're p .d to keep the organization healthy, not perform healing miracles.

Make every system a winner. They will do the same for you.

Enforce a long-haul attitude of "We are all in this together, for the duration," and experiment with ways to reward people equally. Base advancement on the performance of fielded systems during their useful life, and weight rewards according to system age. For a fielded system, increase bonuses by a set percentage for each consecutive year it has performed successfully. Make promotions of program manager and support manager conditional. For program managers, systems in the pipeline must perform as intended, once fielded; for support managers, fielded systems must not deteriorate suddenly.

Take a promotion or two back because a system fails, making sure failure is tied directly to a manager's performance or judgment. If several managers bail out, count yourself lucky.

How Not To Fail—All Managers

For every manager: Take charge of infrastructure elements, early and firmly. Dictate rules and make sure they are followed. Review rules to ensure they are complete and make sense. Give smart people an opportunity to influence rules, and take no pride of rules' authorship. Admit others have good ideas.

Be flexible in applying rules so that unexpected events can be factored into the fielding and sustaining processes as quickly as their impact can be measured and validated.

Whatever your managerial level, remember the math test at the start. If you are a program manager, it will alert you when to get out. If you are a senior executive, it may help prevent a sudden crop of parachute blossoms.

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ADVERSARIAL NATURE OF GOVERNMENT CONTRACTING

Christopher N. Lee

This paper explains the observation that government contracting is relatively more adversarial than commercial contracting. I contend the adversarial nature of government contracting can be explained largely as a rational consequence of constraints on its choice of governance structures.

Section II is a summary of previous discussions of the adversarial nature of government contracting.

Section III develops a simple trade model and illustrates the motive for trade and the existence of destructive tendencies to destroy trade relationships; it explains the basis for institutions seeking to ensure trade parties honor trade commitments.

Section IV is a general description of institutions utilized to ensure trade commitments are met.

Section V applies the trade model to explain why government contracting is adversarial.

Section VI contains conclusions.

Background

Analysts comment on the adversarial nature of government contracting. William French Smith says there is "excessive government participation in the adversary process...." He suggests the use of less adversarial methods of dispute resolution.[1] Two DOD analysts have similar observations.[2]

> Good working relationships have been sacrificed in the interest of legally precise determinations of the liability. Failures to maintain good working relationships have led private contractors to refuse to do Government work and the result has been decreased competition and higher prices to the government.

Industry representatives share these views.[3]

> The DoD is said to maintain an adversary relationship with its suppliers: there is not the cooperation and reasonableness one finds in the commercial world. "You can generally sit down with a commercial customer, analyze problems that have arisen and settle them quietly and effectively," a survey participant stated. The DoD, on the other hand, is characterized as being hard nosed, rigid and inflexible. It also manifests little loyalty to its suppliers, little interest in their long run stability and strength.

A Defense Fuel Supply Center (DFSC) survey provides evidence for the contention that the DOD is more inflexible and adversarial than commercial counterparts.[4] The survey seeks to determine important differences between contracting practices of commercial jet fuel customers like airlines, and contracting practices the Department of Defense utilizes to acquire military jet fuels.

The survey summarizes responses from eight refiners and five large airlines. The refiners collectively supply more than 50 percent of the commercial jet fuel sold in the United States. The responding airlines collectively buy more than 33 percent of all the commercial jet fuel. Collective purchases of responding airlines more than double the DFSC domestic jet fuel purchases although these purchases are larger than any domestic airline.

One survey question tries to discover if there are differences in DOD responses to post-award issues as opposed to responses typical of commercial buyers. All refiners indicate commercial airlines are more likely to resolve post-contractual issues like product quality issues, based on

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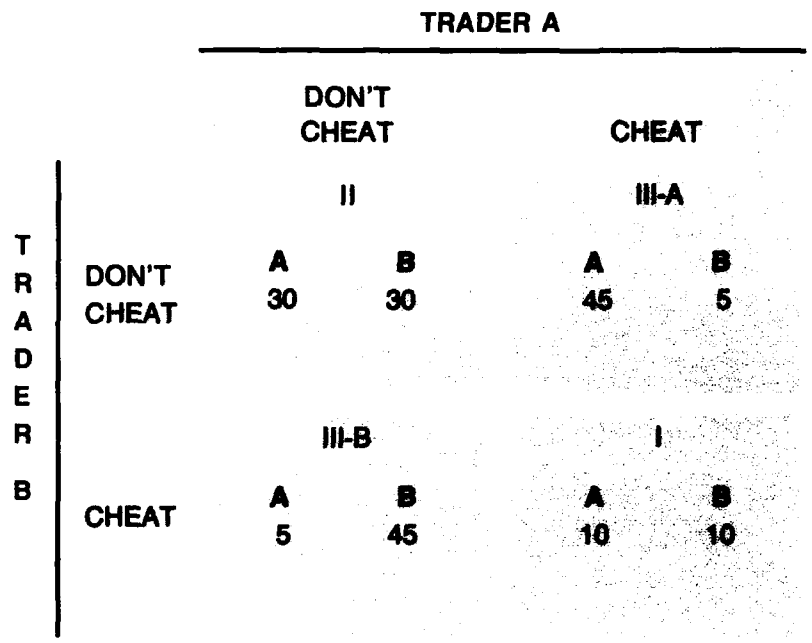
FIGURE 1. UNSTABLE TWO-PARTY TRADE GAME (NO PENALTIES FOR CHEATING)



fairness as opposed the letter of the law. One respondent notes "the airlines are willing to work with us. The government tells us what our obligation is and how they want it done and when without using common sense." Another adds that DOD contract administration is "built on a system of distrust." A refiner says "...airlines are more flexible and have broader latitude in accommodating changes to contracts or purchasing agreements."[5]

Another DFSC survey question tries to determine if there is a difference in the DOD propensity to litigate as compared with commercial airlines. Four of five responding say DOD is the more likely to pursue legal remedies. One refiner comments, "airlines would work with the supplier first." Another adds, "communications with the airlines (verbal, personal visits, letter) occur more often. Problems generally are solved before they become big problems. The DoD waits until the last moment and expects to solve the problems over night. Communication is one way and not very timely."[6]

In a further attempt to determine relative propensities to rely on legalistic solutions to contractual problems, the survey asks refiners to reveal how often during the last 5 years a contractual dispute between refiner and an airline involved active participation of its legal staff or outside counsel; five responding refiners had no occasion to involve their legal staffs in a dispute with an airline. One indicated it had three occasions, another had two.[7]

This reported aversion to litigation within the commercial sector is consistent with research. Stewart Macaulay reports it is rare for commercial firms to litigate claims; he says commercial firms rely primarily on non-contractual remedies.[8]

Government agencies are more likely to use legalistic remedies. It is the normal practice within the Defense Fuel Supply Center that counsel be intimately involved in resolving important contractual disputes. One indicator is the extent of Defense Fuel Supply Center litigation compared with industry. Based on average litigation during the last 4 years, more than 40 cases per year, DFSC litigation would total more than 200 cases during 5 years.[9] This contrasts to industry's five occasions using counsel.

What accounts for this? Some say a new management philosophy is needed, or that it results from acquisition personnel with insufficient authority to do their jobs.[10] This paper gives an alternative explanation in terms of relative costs of governance structures. The following section develops a simple trade model.

A Two-Party Trade Game: Construction and Analysis[11]

Hypothetical gains from trade and possible incentives to cheat that might destroy the trading relationship are illustrated in a simple two-party trade model with payoffs as shown in Figure 1.

Values can be viewed equivalently as capital values expressed in dollar terms or as utility indicators.

Quadrant I represents a world in which no trade takes place because neither party will honor commitments. Quadrant II is socially preferred in the sense it is the only quadrant where both parties are made wealthier as compared with their initial wealth position represented by Quadrant I. Quadrant II-A represents payouts if A cheats while B honors commitments. Quadrant III-B represents payouts if B cheats while A honors commitments.

Even though Quadrant II is the socially preferred position, it is not the equilibrium or solution position because each party has an incentive to cheat. To understand this, consider the trade game from A's perspective, who knows that B has two options: Honor the agreement or cheat.

If B honors the contract, A can increase his wealth from 30 to 45 by cheating relative to his strategy of honoring the contract. If B cheats, A is better off to cheat as opposed to honoring the contract because he can increase his wealth from 5 to 10. Because the matrix is symmetrical, what is true for A is true for B. Hence, the optimal strategy for both is to cheat.

Players have an incentive to alter the game structure to ensure the cooperative outcome tends to emerge or become the dominant strategy. They may recognize that a dishonest trader

cheats only when profitable. If possible to alter the game payouts so that cheating does not "pay," both traders would cooperate and receive trade benefits.

Consider the possibility that players develop, in theory, the revised game shown as Figure 2.

The revised game has a penalty of 20 for cheating. A penalty exceeding the gain from cheating of 15 makes cheating unprofitable. With a penalty of 20, the cheater is worse off than when cooperating since net wealth falls to 25 from 30. Both players would agree rationally to accept the revised game, with penalties, because it ensures the cooperative solution will emerge.

This theoretical solution begs an important practical question: What is the source of the penalty points and who ensures they are assessed? The answer follows.

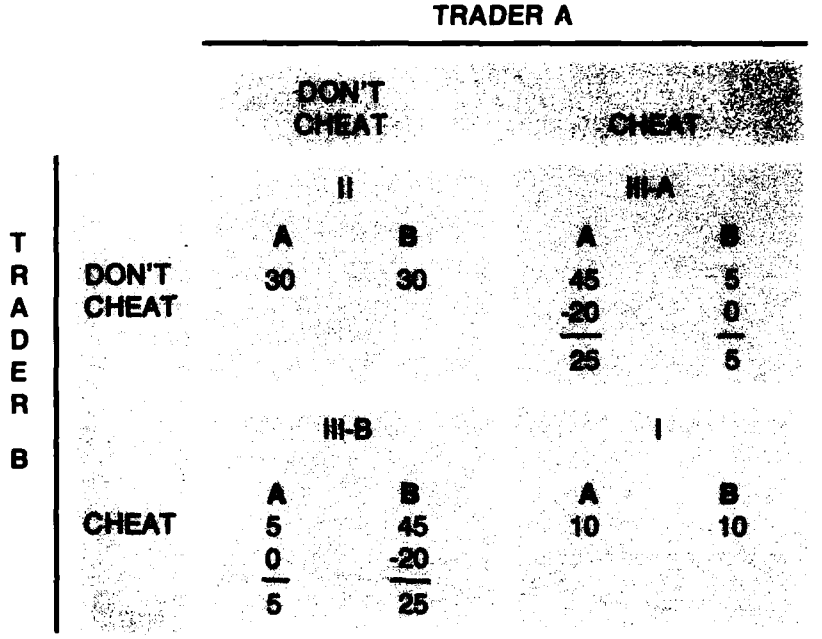
Trade Enhancing Institutions: Creation of Governance Structures

Here, I describe institutions helping preserve trade relationships, called governance structures. Cost of creating and maintaining these are transactions costs. Governance structures will be termed informal if they do not utilize a formal written contract. They will be termed private if they do not utilize the state's police powers to enforce the agreement.[12]

Governance structures introduce penalty points into the trade game so that cheating is unprofitable. This requires the penalty consequences of cheating to exceed its potential benefits. Following are outlines of more important governance structures.

—FORMAL CONTRACTS.[13] This is the traditional governance structure in which the proposed trade is reduced to a formal contractual document. Penalty points described in Figure 2 are embedded in the contract and enforced within the court system.

FIGURE 2. STABLE TWO-PARTY TRADE GAME (PENALTIES INCLUDED FOR CHEATING)



—LOSS OF FUTURE SALES.[14] This is an informal, private governance structure. Using this, the customer refrains from future purchases if a supplier does not meet expectations. Alternatively, the customer can shift business to companies providing relatively superior services, away from suppliers providing relative inferior services. Potential loss of sales is a source of penalty points as shown in Figure 2.

—GET HOSTAGE.[15] This is an important informal private governance structure used in commercial transactions. The penalty source is potential loss of the hostage. Two principal hostages utilized in commercial transactions are goodwill capital and customer specific productive assets.

In either case, the supplier would suffer a capital loss if the customer becomes dissatisfied and terminates the relationship because the supplier could not dispose of assets at their value to the ongoing concern. This potential loss of capital value represents another source of penalty points as shown in Figure 2.

—TRADE WITH FRIENDS.[16] This is an important and informal private-governance structure. It is important when respective duties require a high degree of trust or confidence like activity not easily measured or monitored. This governance structure utilizes the threat of damage to one's social esteem as its penalty source.

—VERTICAL INTEGRATION.[17] Firms may vertically integrate when they cannot find economical means of creating governance structures like those outlined above. As a result, they do it themselves.[18] In this case, the "trade" is internalized as opposed to being between separate players.

—REGULATION.[19] Victor Goldberg, proponent of the regulatory solution to the trade game, argues that formal contracts are not a solution to the trade game because future contingencies cannot be anticipated sufficiently well to permit adequate resolution in a formal contract. He recognizes trading parties may become dependent on each other, possibly permitting opportunistic exploitation.

Adversarial Consequences of Restricted Governance

Considering the six principal types of governance structures outlined, it is apparent the government is more limited in its choice of governance structures than are commercial traders. In particular, the government cannot make as effective use of Structures 2, 3, 4 and 5.

Consider Number 2. If two firms equally meet a minimum level of performance, although one is superior, the government often evaluates them as equal.

Consider Number 3. The government ordinarily does not take existence of hostages into account in bid evaluations. Firms without goodwill capital on the line are typically evaluated the equal of firms risking considerable amounts of goodwill capital.

Consider Number 4. Obviously, the government cannot limit trade relationships to friends and relatives.

Consider Number 5. Government decisions to integrate are not normally the result of any such analysis discussed in this paper.

Number 6 is ruled out by assumption since we are considering only contracting outside the regulatory environment.

What governance structures does this leave the government to utilize? Only Number 1.

Government contracting is constrained to place greater reliance on formal contractual documents as compared to commercial contracts for similar purposes. I argue this implies DOD contractual documents tend to be more detailed and complete than commercial contracts.[20]

It is a straightforward extension of this logic to argue that since the government does not make effective use of informal governance structures and is, accordingly, left with the formal contract as its primary governance structure, it must make every effort to enforce that agreement exactly as written.

The trade game as seen in Figure 1 has powerful incentives to cheat, destroying a trade relationship. Adversarial propensities are part and parcel of trade relationships. If penalty points can be injected into the trade game, represented by Figure 2, it is possible that the cooperative solution can emerge despite destructive tendencies.

Choice of governance structures will affect adversarial character of the trade relationship. One characteristic of informal governance structures is pushing destructive tendencies into a gestault-like background so that trade participants may not be aware explicitly of underlying destructive tendencies. This does not remove destructive tendencies. Instead, they are outweighed by informal penalties. An effective penalty system can cause player cooperation "as if" they were truly a joint-maximizing team.

Consider the observed cooperation between labor and management in Japan. You can use the trade game model in Figure 2 to explain. Labor presents a "bond" by being paid less than their marginal product during early years with a firm, in return for being paid more than the marginal product in later years. The firm presents a goodwill bond via a reputation for fairness to employees. Violating this reputational bond, the firm would have to raise its offer wage to attract future employees. This mutual bonding overcomes destructive tendencies but does not remove them.

Klein, Crawford and Alchian note that the penalty to the firm for cheating is greater when its growth rate is higher, saying Japanese firms have experienced a high growth to explain company "loyalty." High-growth-rate firms, like the Japanese, are no more "loyal," but behave "as if" they are, facing greater penalty consequences when cheating.[21]

Character of the trade relationship is fundamentally different when players try to control destructive tendencies using only the formal contract without help from informal governance structures. Now strains are clearly in the foreground. In this situation the players, particularly commercial suppliers, have an economic incentive to "work to the rule." Governments agents, in response, have good reason to be strict.

Unlike commercial counterparts, government contracting agents cannot punish a firm that works to the rule. Consequently, the government cannot use the informal governance structure of placing an increasing portion of its orders with relatively more cooperative vendors.[22]

This might account for Phillip Cooper's observation that "one of the peculiarities of the government contract is that it is a contract of adhesion. The contracting officer writes the document and the contractor is left with a take-it-or-leave-it situation."[23] It is instructive that Cooper views government contracting as relying on formal governance structures rather than informal as the following quotation illustrates.[24]

> The basis of a contract is that it is an agreement binding two parties for the performance of a particular service or provision of a product for a specified price, usually within a specified period of time. When the contract ends, the relationship ceases. This separation occurs when the product or service is delivered or the time expires for payment or delivery.

This near-exclusive reliance on the formal contractual governance structure implies contracting personnel will be required to enforce the contract according to its literal meaning. That, in turn, may account for the observations of some analysts that government contracts encourage reliance on objective decision criteria.[25] It provides partial explanation for the government fetish with objective quality standards and its severe attitude of enforcement. Industry often complains the government is unreasonable in quality-assurance testing and acceptance, citing that as an important reason for refusing government business.[26] If I am right, there is a good reason for these stringent criteria.

Conclusions

This paper takes issue with the view that the observed adversarial character of government contracting is a product of "philosophy" or "attitudes" or poorly trained employees. I maintain the adversarial relationship can be explained in terms of restrictions on government choice of governance structures.

Private and government contracting parties want contracting relationships where promises are fulfilled. To do this, penalty points must be introduced

into the trade game as shown in Figure 2. There is a menu of possible governance structures from which contracting parties can choose to accomplish this goal.

Menu prices facing government and commercial contracting agents are not equal. Regulatory constraints increase government menu prices of informal governance structures relative to prices facing commercial contractors. This causes government contracting personnel to place near-exclusive reliance on the formal, written contract.

In a previous article, I argued this would cause government contracting agents to draft contracts with extreme care to cover every contingency. The predictable result is that government contract clauses are longer and more complete than commercial clauses for a similar purpose.[27]

This article extends that logic by arguing that exclusive reliance on formal contracts promotes a "work to the rule" attitude to which the so-called adversarial nature of government contracting personnel is a natural response.

Endnotes

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4. Christopher N. Lee, "Survey of Contracting Practices," June, 1989.

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6. Ibid.

7. Ibid.

8. Stewart Macaulay, "Non-Contractual Relations in Business: A Preliminary Study," *American Soc. Review* 28 (February 1963), pp. 55-67.

9. Defense Fuel Supply Center, *State of the Center Briefing*, 1989.

10. President's Blue Ribbon Commission on Defense Management, *A Quest for Excellence*, (June 1978), p. 42.

11. This article represents an application of an earlier article. See Christopher N. Lee, "Government Contracting: A Game-Theoretic Analysis," *The Public Contract Law Journal* (Winter, 1989). Article contains expanded version of material contained in Sections III and IV and may be beneficial to readers unfamiliar with prisoner dilemma models.

12. See generally, Oliver E. Williamson, *The Economic Institutions of Capitalism*, (New York: The Free Press, 1985).

13. See generally, Stewart Macaulay.

14. See generally, Benjamin Klein and Keith B. Leffler, "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy*, Vol. 89 (January 1981), pp. 615-641.

15. See generally, Oliver E. Williamson. "Credible Commitments: Using Hostages to Support Exchange," *American Economic Review*, Vol. 73, No. 4 (September 1973), pp. 519-540.

16. See generally, Yoram Ben-Porath, "The F-Connection: Families, Friends, and Firms and the Organization of Exchange," *Population and Development Review*, 6 (March 1980), pp. 1-30.

17. See generally, Benjamin Klein; R. A. Crawford, and A. A. Alchian, "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," Jay B. Barney and William C. Ouchi, Eds., *Organization Economics*, San Francisco: Jossey-Bass Publishers, 1986, pp. 615-641.

18. See generally, Ronald H. Coase, "The Nature of the Firm," *Economica* 91937, reprinted in Stigler and Boulding, Eds., *AEA Readings in Price Theory*, (Homewood: Richard D. Irwin).

19. See generally, Victor Goldberg, "Regulation and Administered Contracts," *Bell Journal of Economics*, (Autumn 1976) 7, pp. 426-448.

20. See generally, Lee, "Government Contracting."

21. Klein, Crawford and Alchian, pp. 56-56.

22. Jagdish N. Sheth, Robert F. Williams and Richard M. Hill, "Government and Business Purchasing: How Similar Are They?" *Journal of Purchasing and Materials Management*, (Winter 1983), p. 11.

23. Phillip Cooper, "Government Contracts in Public Administration: The Role and Environment of the Contracting Officer," *Public Administration Review*, September/October 1980), p. 465.

24. Ibid., p. 462.

25. Wendy T. Kirby, "Expanding the Use of Commercial Products and 'Commercial-Style' Acquisition Techniques in Defense Procurement: A Proposed Legal Framework," The President's Blue Ribbon Commission on Defense Management, *A Quest for Excellence*, Appendix H, (June 1986), p. 92.

26. David V. Lamm, "Why Firms Refuse DoD Business: An Analysis of Rationale," *National Contract Management Journal*, Vol. 21(2) (Winter 1988), p. 52.

27. Lee, "Government Contracting."

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GOVERNMENT CONTRACT
ADJUSTMENTS VS. APPROPRIATION ACCOUNTING

Discussions in the cost accounting standards course and consulting studies show a lack of understanding regarding funding of government contracts. Different people involved with government contracts are unaware of impacts their decisions have on funding structures of contracts. All contracts are not funded from one money source. Thus, contract adjustments for cost misallocations and mismeasurements must consider impact on government funding. Having the contractor correct accounting records and/or getting a check returned from a contractor may not equitably resolve the issue, especially when adjustment involves a closed contract.

Some misunderstanding is due to specialization in the vast area of government procurement.

On the buying side are people concerned with funding government contracts.

On the contract administration side are people involved with government contract cost accounting.

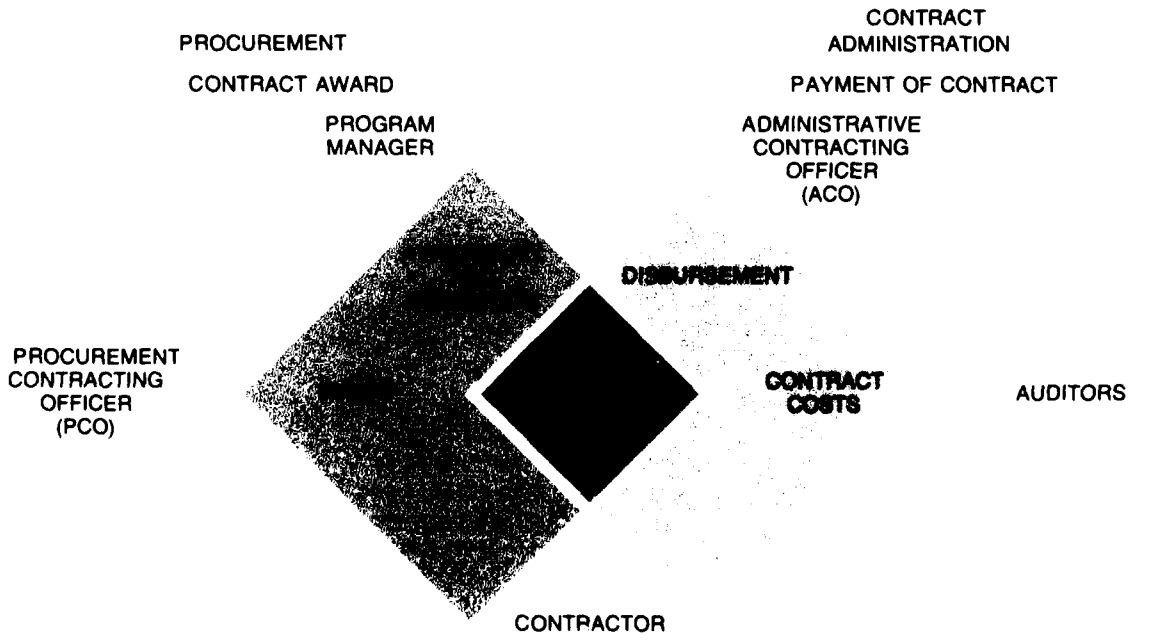
Participants and their major concerns are shown in Figure 1. At the center is the issue of this article, *appropriation accounting*. When contract adjustments are made affecting funding, it is necessary to assure adjustments are properly recorded using appropriation accounting rules. Constant budget restrictions worsen the problem, increasing need for everyone to be aware of the relationship between contract adjustments and appropriation accounting.

Contractors may not be interested in appropriation accounting but are not divorced from the issue. The contractor and administrative contracting officer (ACO) are at the heart of the problem. Once funding starts participants on the buying side become involved. It is incumbent that players understand appropriation accounting to assure proper treatment of adjustments. Improper handling of adjustment transactions could involve the Inspector General.

Colors of Money

Paper money the government spends may be green but "pots" out of which it is paid are different colors. Funds are not alike. There are characteristics distinguishing different funds: appropriation, fiscal year, agency, Department of Defense program and agency program/project. This is what *numbers* mean in an accounting classification accompanying a government check.

FIGURE 1. PARTICIPANTS AND MAJOR CONCERNS



Characteristics of these funds represent layers of control, starting with appropriation. Each year the Congress passes 13 appropriations acts that are signed into law by the President. The DOD Appropriations Act is one. Within DOD, there are separate appropriations for each department—Army, Navy, Air Force—complicating the adjustment issue seen in Figure 2. A contractor with several contracts from buying agencies (Army, Navy, Air Force, National Aeronautics, Space Administration) may easily make an adjustment for misallocation of costs on the contractor's books. Effect of the adjustment may cut across different appropriations belonging to different departments.

Three Major Categories

Proper accounting for appropriations requires segregation into three major categories: research and development, investment and operations. Research and development costs are recorded expenses on government books. Investment appropriations are procurement funds to purchase assets like ships, tanks, aircraft and weapons. Construction funds are for buildings and facilities and are in the investment category. Operating funds are for daily operation and maintenance expenses like salaries, supplies, equipment, service contracts and travel.

Even with three major categories of appropriations, each government department receives its categories of appropriations identified specifically to that department. Each buying agency has a set of procurement funds. A contractor with Army, Navy and Air Force contracts may think these funds are alike because that contractor is dealing with one accounting office responsible for administering all of his contracts. Even a contractor having contracts with one agency can impact different appropriations at one point in time; for example, a contractor may have a fixed-price contract to produce x aircraft, and, at the same time, a cost-reimbursement contract to research and develop a new landing gear.

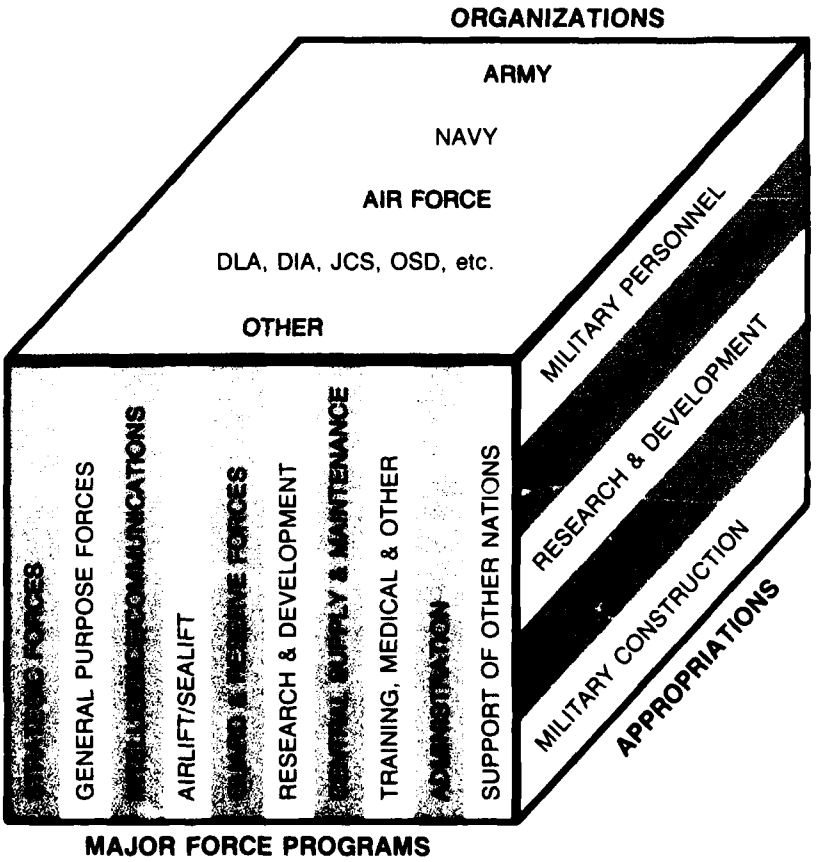


FIGURE 2. FIVE YEAR DEFENSE PROGRAM STRUCTURE

FIGURE 3. PROCUREMENT APPROPRIATIONS AND PROGRAMS

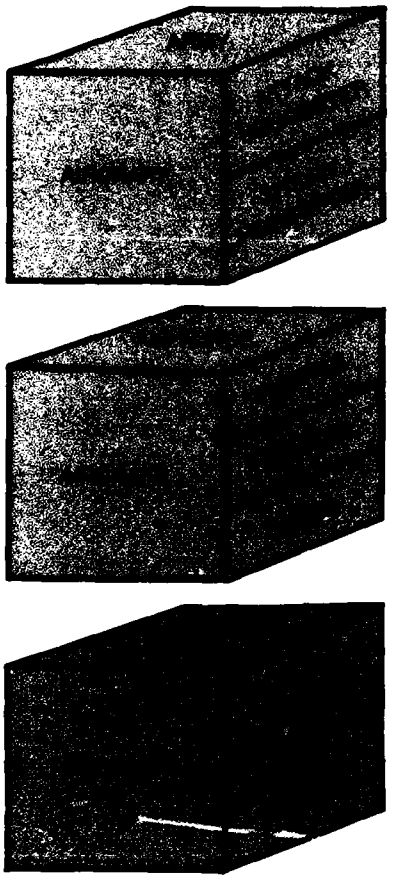
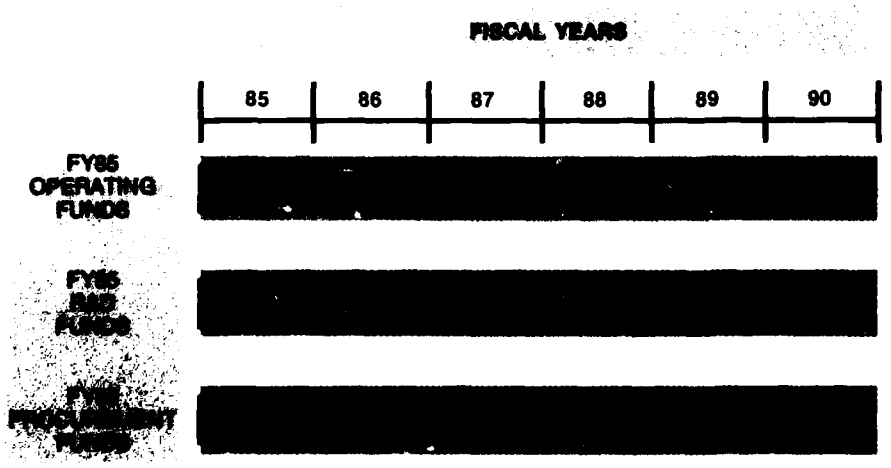


FIGURE 4. APPROPRIATION STATES



Different Shades

Besides different colors of money for different purposes, each department has different shades of the same color. Each source of procurement funds for each department is divided into programs as shown in Figure 3. Each program manager may have lower-level subprograms and/or projects within a program; for example, the attack helicopter program may have subprograms for the engine, electronics, hydraulics and weapons systems.

Figure 2 shows another level of accounting between the appropriations from the Congress and organizations within DOD, which segregates each appropriation into 10 DOD programs to develop the five year defense program (FYDP). The DOD does not focus on each separate appropriation but on the mix of funds within its program structure to accomplish objectives.

The Congress places another control on each appropriation in the form of a fiscal year, limiting length of use. A widespread misconception is that all appropriations are open forever and the available funds can be used at any time. In reality the open state is one of three states (open, expired, merged) through which all appropriations will pass.

Figure 4 shows examples of each major category of appropriation and the time each is in a particular state. Although procurement funds are shown to be open for 3 years, the timeframe is different depending on item being procured; for example, different classes of vessels can take 5-8 years to build whereas a contract to build x number of tanks may be open 3 years.

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Different States

It is the different states of the appropriation that cause the most problems when making contract adjustments. *Open state* means the appropriation is available for obligation, adjustment and disbursement. When the appropriation moves into the expired state it no longer is available for new obligations but can be used for adjustments and disbursements. After the expired state the appropriation is closed and merged with previous fiscal years that are closed. Funds are available for a *limited* time, making the area of contract adjustments critical.

Figure 5 shows complexity of contract adjustment when all levels of control are viewed at once. This figure shows six sides of a cube pulled from one shown in Figure 2. Each side represents a control measure that must be considered when making contract adjustments. In negotiating contract adjustments, the administrating contracting officer has issues to consider. Will the adjustment result in decreased obligations thereby making funds available? Will funds revert to the Treasurer of the United States? Can funds be reused by the program manager? Will the appropriate program manager get to use the funds? Have appropriation accounting rules been violated?

Contract Adjustments: Problems

The administrating contracting officer faces a double-edged sword when negotiating a contract adjustment, the first edge being to convince the contractor an adjustment is necessary.

Once this is accomplished, that officer faces the next edge involving weighing the appropriate adjustment by considering the buying agency, contract and appropriation accounting rules. The problem becomes complex when contracts are covered by cost accounting standards (CAS). Recovery under CAS-covered contracts is restricted to those open at adjustment; closed contracts exacerbate the ACO's dilemma.

To appreciate the ACO situation and accounting problem, I will examine three scenarios. Data for two examples are in Figure 6.

FIGURE 5. SIX LEVELS OF CONTROL

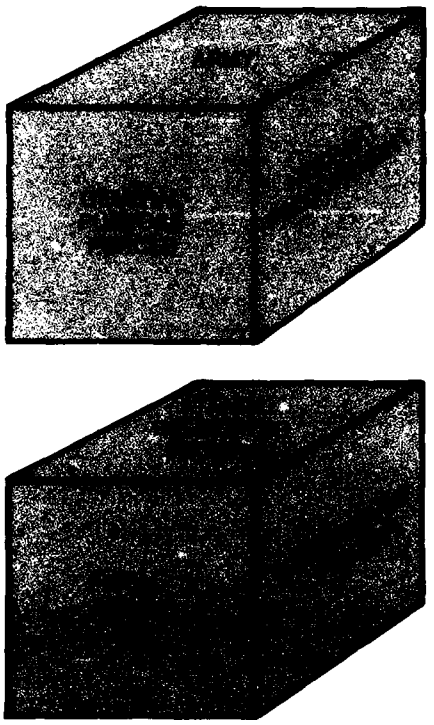


FIGURE 6. CONTRACT ADJUSTMENT SITUATIONS OPEN CONTRACTS

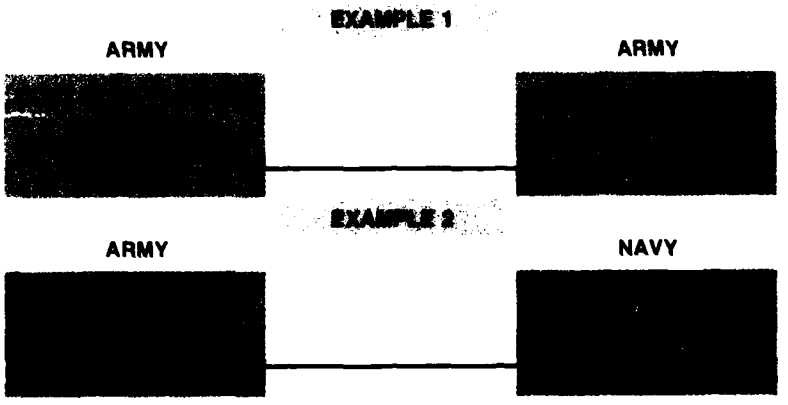
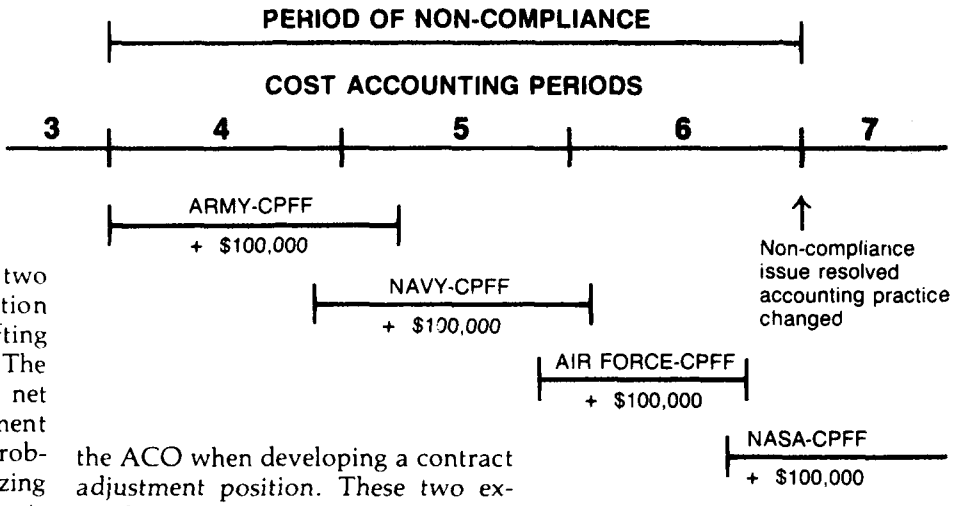


FIGURE 7. CONTRACT ADJUSTMENT



The first example concerns two Army contracts where a misallocation of costs resulted in $100,000 shifting from one cost contract to another. The contractor's reaction is that the net effect is zero; therefore, no adjustment is necessary. There is a funding problem because Contract 2 is subsidizing Contract 1 and these two contracts may involve separate appropriations and programs. If the adjustment is made by the contractor correcting the records, this will fix the misallocation problem through subsequent vouchers but may cause another problem. What happens if the contractor does not submit vouchers monthly on Contract 2? This means the contractor will recover under-billed costs on the next monthly voucher for Contract 1 but the government may not realize recovery of the over-billed/paid costs on Contract 2 for a few months. Timing difference will give rise to the assessment of interest, another problem to resolve.

A "Wash"

The second example involves misallocation of $100,000 from the Army fixed-price contract to the Navy cost contract. Again, the contractor would say no adjustment is necessary because the misallocation is a "wash" (i.e., nets to zero). The misallocation did not affect funding of the Army fixed-price contract if the proposal was submitted with compliant accounting practice. The Army will pay the fixed price regardless of misallocations. The Navy will finally pay $100,000 more on its contract, increasing obligations and affecting Navy funding. The ACO should negotiate an adjustment to get funding back where it should have been before misallocation. A records correction by the contractor will put the $100,000 back on the Army fixed-price contract and reduce costs billed to the Navy on the cost contract. Funding becomes a major concern to the ACO when developing a contract adjustment position. These two examples concern open contracts in two, separate and oversimplified scenarios.

The next situation (Figure 7) extends the accounting problem to closed contracts of several different departments. A non-compliant accounting practice caused misallocation of costs to each CAS-covered cost contract. The shift could have been from commercial contracts and/or non-CAS covered contracts. Regardless of origin, result of misallocations was the government overpaying $100,000 on each CAS-covered cost contract. How should adjustment(s) be made?

The open NASA contract can be adjusted with a records correction that will effect recovery on the next voucher. How do you recover on closed contracts? Do you get a check from the contractor? Probably, the check will go to the Treasury, meaning no other department will benefit from the recovery. The stage (open, expired, merged) of each appropriation must be examined to determine if recovered funds can be used by that department.

Material Requirement Planning

The adjustments emanate from an ACO decision after consulting with auditors and accounting office. There are adjustments every day affecting funding unknown to the ACO, auditors and accountants. These cost transfers are made using the guise of material management and accounting systems, more commonly labeled as Material Requirements Planning (MRP).

These automated inventory systems make continuous transfers of material among contracts. Material bought for one contract could be transferred to others. The borrow/payback system does not always get the appropriate cost back to respective contracts. The result of adjustments is that small contracts could benefit at the expense of large contracts.

If a contractor has only government contracts, the problem is not resolved because it finally averages out since contracts are not funded from the same source. Program managers compete for limited resources, bringing the problem to the program level. This is not a contract-costing concern of the contractor but it cannot be ignored.

Contract adjustments for inventory transfers and cost misallocations can be achieved by many methods. Two popular ones are a records correction or getting a check from the contractor; however, these and other solutions have problems.

Solutions Causing More Problems

The first order of business to make contract adjustments should be correcting records. This is imperative because records are the basis of future estimates. If records are incorrect everything based thereon will be incorrect. Sometimes a records correction will not result in recovery, or cannot be made.

A records correction will not result in recovery when non-compliance is in the estimate of a firm fixed price (FFP) contract priced higher than usual. Correcting records to reflect the lower allocation to the FFP contract will not affect the price. The contractor still receives the higher negotiated price unless there is a supplemental agreement to bring the price down to where it should have been without non-compliance.

If a contract adjustment involved closed contracts in prior years, a records correction cannot be made. When a year's cost-accounting records are closed there will be no prior-period accounting adjustments for misallocations of costs; recovery would have to be by check, creating more problems.

No Panacea

Getting a check back from the contractor is no panacea. Funds recovered may not revert to the affected buying agency; even if they did, that agency might not be able to use the funds because of the stage of the appropriation. If the check goes to the Treasury, using the funds is lost forever; to preclude losing funds, a creative accounting technique has been developed.

Recovery of funds resulting from a contract adjustment can be achieved by the contractor establishing some type of liability to the government. The liability is reduced by billings to the government for current and future contracts. This solution has its obstacles-business mix. If this technique is to function accurately, current and future business mix has to be the same as the past mix for which recovery is being made.

Looking at Figure 7 you will note the business mix changed during non-compliance. In this situation, NASA would benefit from liquidation of the contractor's liability since the three services do not have current contracts. Loss of funds has been avoided but the benefit does not revert to affected agencies.

Another obstacle to this technique is appropriation accounting. Even if other services had current contracts, the recovery would be made against current, open appropriations which are not the appropriations originally obligated. A questionable technique has been created to circumvent losing funds, and the result may be an unfavorable audit finding.

Another contract adjustment, supplemental agreement, has drawbacks; it is used to increase or decrease the contract price. It will affect only the obligation of funds initially. Recovery of over-allocated costs will not occur until the end of the contract when disbursements equal the obligation.

Funding Is Everyone's Business

Contract adjustments are not problems of only the ACO. All players identified in Figure 1 have stakes.

The procurement contracting officer is concerned with contract award that affects obligation of funds and fund availability.

The program manager wants an end-product at a fair price that involves availability of funds.

The accounting office records the obligation and disbursements against fund availability.

The ACO, contractor and auditors monitor contract costs to stay in line with availability of funds. The issue of funding becomes everyone's concern.

Contractors cannot view contract adjustments and funding problems as a zero-sum game.

Accountants and auditors cannot play "Monday morning quarterback" and second guess the administrating contract officer after the fact.

The procurement contracting officer and program manager cannot watch from the sidelines.

All players must be in the game lending assistance and expertise *before* the decision is made. Appropriation accounting rules are complex and require input from experts *before* the contract adjustment decision is made.

Program managers compete for limited resources, bringing the problem to the program level. This is not a contract-costing concern of the contractor but it cannot be ignored.

David D. Acker

QUESTIONS PROMOTE EFFECTIVE COMMUNICATION

How important are questions when it comes to effective communication? Do they have a role? Would our communications be as effective if questioning was discouraged? I think not. Questions play a vital role in effective communication. An English proverb states "Many things are lost for want of asking."

While preparing the revision to my book, *Skill in Communication, A Vital Element in Effective Management*, a friend asked: "Are you going to include a discussion of the importance of questions in the new edition? This was a good question. My answer, of course, was immediate and affirmative. Unfortunately, I neglected to point out the importance of questions in the first edition. Firch recognized the importance of questions when he wrote that questions "...set the learner's thinking...promote activity and energy on their parts, and...arouse the whole mental faculty into action.[1] When Gertrude Stein was dying, she asked her companion, Alice B. Toklas: "What is the answer?" Then, Miss Toklas asked her: "What is the question?"

Effective communication involves a two-way flow of information from sender to receiver and then from receiver back to sender. The reverse flow consists of questions, comments, ideas, and so on about opportunity to clarify the message conveyed and indicates to the sender how much of his message has gotten through and is understood. Wilford A. Peterson suggests we be inquisitive listeners. Ask questions. Everyone has something to say that will help us grow.

Kinds of Questions

We face three kinds of questions. The first are big, perennial and open-ended. They are concerned with the ends of men. They involve us in continuing debate.

The second are the means/ends questions. They require good answers, which may not be final.

The third are the little, important ones. They are questions of means only. The answers to these are of limited scope.[2]

Let's look at these questions another way. First, there are questions dealing with life management. What is the most effective way to learn to read and to write, to speak and to listen, and to observe and visualize?

Second, there are questions you ask as a manager. You have probably asked yourself: "How do I get the time, the energy, and the budget to do what is important?" How do I find the time to work with my professional society, the Boy (or Girl) Scouts, my church, club, other organizations? How do I find time to read interesting reports, books and magazines available to me daily? These are critical management questions.

Finally, there are little questions like: Where do you look for...? What does one do to...? Why do I have to...? How do I get from A to B? These questions are important, but the real challenge each faces is: "Where or how do I find the answers?"

Let's consider the role of questions in day-to-day conversations. The role appears to be clear. When talking to someone, you or your friend might ask for more information, clarification of a comment, the source of more information, or any of a myriad of questions. "You recognize the reality of facts," says Peterson, "but you use your imagination to penetrate beneath them and to project your thought beyond them in your search for creative answers to problems."

In communications between two people, or several people, the degree of understanding is enhanced and broadened by questions along the way. During a conversation with a friend, instead of asking a specific question, it may be worthwhile to repeat something your friend has just said in a questioning tone of voice. The response received will often lead to further information that can add to

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Professor Acker is a senior member of the research staff in the Department of Research and Information at the Defense Systems Management College. *This article will be a new chapter in the second edition of his widely acclaimed book* Skill in Communication: A Vital Element in Effective Management *which is planned for publication in 1990.*

understanding your friend's comment. It is through questions and answers that conversations lead to new levels of understanding. The conversation becomes an enriching experience.

Questions After Presentations

After a speech or presentation of ideas on a special topic, the speaker normally takes questions from the audience. This is worthwhile. He may have had more information to share, but couldn't do it in the time allocated. On the other hand, through questions he learns whether the audience understood the basic message, received a right or wrong message, or found gaps or flaws in the presentation. The questions, then, become a learning experience for speaker and audience. Socrates, the great teacher, asked questions of his audience; then, he questioned the answers.

During the question-and-answer period after a presentation, the audience has an opportunity to elicit more information, clarify points of interest, and learn where to obtain additional information on the subject of the presentation, to correct misunderstandings, and to air points of agreement or disagreement. Generally, questions by the audience are neutral, non-judgmental, and non-accusing. The audience is seeking to keep the subject at hand flowing along the theme established by the speaker. This give-and-take is often the most important for ensuring that effective communciation takes place between the speaker and the audience.

Now, let us consider two special types of questions, probing and confrontational.

Probing Questions

Probing, using a question requiring more than a yes or no answer, is a skill that either gives you more information or assists you in focusing on a situation. Some typical statements of a probing nature are:

—What are your thoughts about...?

—I'm wondering what your reaction is to...

—Can you tell me more about...?

Probing directs the speaker to think more deeply about the topic. Using this skill, you may be able to have the speaker identify additional matters that you want him to focus on or pursue further.

A probing question, which is an open-ended question, cannot be answered with a simple yes or no. If you wish to explore a subject in more detail, avoid questions beginning with Do, Is, and Are. They can be answered with one word. Instead, raise questions beginning with What, Where, When, and How. Or, consider using a statement like "Give me more information about..." or "Tell me more about...." Why, not as effective as the four just cited, may elicit a defensive response because people are not always clear about their motives.

Confrontational Questions

Confrontation is the deliberate use of a question to assist the speaker to focus on an area or subject he seems to be avoiding. "Actions speak louder than words," so confrontation is used to make the actions of the speaker match the words he uses. Contradiction may arise between the way the speaker sees himself and the way others see him.

An effective confrontation is directed at something it is possible to change. It is best not to have a confrontation until you have established a relationship of common respect with the person you are going to confront. Reactions to confrontations vary. If the person accepts the confrontation, it is desirable to make a positive statement to reinforce the action. However, if the person denies the confrontation, it is desirable to listen carefully to what he says. He might be confused or unclear as to what was meant by your statement. In that case, you might have to clarify what you had in mind.

Confrontation is one of the most powerful communication tools at our disposal. It can help a person assume responsibility for his behavior and build a feeling of honesty and trust. Of course, there are some risks involved when confrontation is used. It is your responsibility, then, to judge whether the situation and timing of the confrontation are such that the other person will benefit from it.[4]

Final Thoughts

Answers to all questions, according to Dale, come from three sources: one's memory bank, computer storage banks, and other memory banks like encyclopedias, dictionaries, and yearbooks. We should spend time on the higher mental processes of critical questioning, evaluating, and applying what is available rather than on lower mental processes like memorizing. Thornton Wilder wrote "there is no true education save in answers to urgent questioning. Unease and deprivation awaken...the mind to inquiry."[5]

John Stuart Mill suggested we "...question all things; never turn away from any difficulty; accept no doctrine either from ourselves or from other people without a rigid scouting by negative criticism; let no fallacy, or incoherence, or confusion of thought, step by unperceived; above all, insist upon having the meaning of a work clearly understood before using it, and the meaning of a proposition before assenting to it. These are the lessons we learn from ancient dialecticians."[6]

George Santayana reminds us that "By nature's kindly disposition most questions which it is beyond man's power to answer do not occur to him at all."

Endnotes

1. Joshua G. Firch, "The Art of Questioning," *The Teacher's Mentor*, 1880.

2. Edgar Dale, "The Art of Questioning," *The News Letter*, Volume XXXIV, Number 3, December 1968.

3. Ibid.

4. Notes from a lecture by Susan Scott of Susan Scott and Associates, Lincoln, Neb., at the Defense Systems Management College, January 5, 1987.

5. Thornton Niven Wilder, *The Eighth Day*.

6. John Stuart Mill, inaugural address as rector of the University of St. Andrew, February 1, 1867.

PROGRAM manager