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Should Cost/Will Cost/ Must Cost

a theory on the cause of cost growth

Army SAFEGUARD System Office

JUNE 1972

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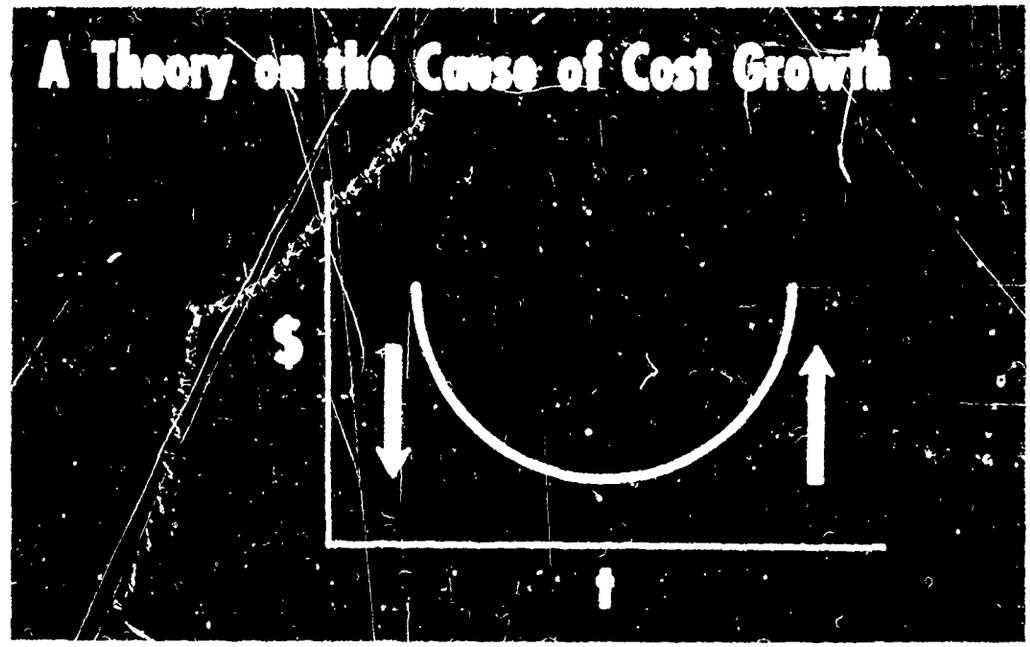


JUNE 1972

OFFICE OF THE ASSISTANT FOR COST ANALYSIS
U.S.ARMY SAFEGUARD SYSTEM OFFICE
ARLINGTON, VIRGINIA 22209

SHOULD COST/WILL COST/MUST COST

-A THEORY ON THE CAUSE OF COST GROWTH-

June 1972

Office of the Assistant for Cost Analysis
US Army SAFEGUARD System Office
Arlington, Virginia

PREFACE

Under the caption of "Here We Go Again," Business Week Magazine of 26 June 1971, presented a brief editorial related to the cost growth problems of Lockheed and more recently Grumman. The editorial concludes:

> "This sort of thing makes a joke--and a very bad joke at that--out of military budgeting. It shows, if any further evidence was needed, that neither Congress nor the public really has any idea of how much the Nation will have to spend for military procurement or what it will get for its money.
>
> "It is time for Congress to ask just how many more cases like Grumman and Lockheed the military has up its sleeve. And it is past time for the Administration to undertake a review and reform of the procurement policies that made such cases possibl

Nor is disple with the conduct of the weapons acquisition process a new development. More than a year ago the National Security Industrial Association diplomatically introduced their study of the defense acquisition process with:

> "Pressures for reduction in dollars spent for defense and for resources to be applied to other purposes, as well as the enormous costs of today's weapon systems and concern about the growth in these costs, have led to increased interest in the defense acquisition process."

Some ten years ago Peck and Scherer observed in the opening remarks to their landmark study, The Weapons Acquisition Process:

> "That there is some feeling of discontent with the way in which the process is carried out can be judged from the numerous congressional and executive department studies of one or another aspect of weapons acquisition."

The immensity of the Department of Defense coupled with its necessarily compartmentalized and decentralized activities makes most difficult an understanding of the total process which can and will, witness the Lockheed and Grumman cases, give birth to events that shake the very foundations of public confidence.

There is a place in this seemingly unfathomable, hierarchial maze of people, projects and programs where, albeit in microcosm, a focusing of the weapons acquisition process takes place. This place is the program office of a major weapon system manager. Individuals serving in these program offices have a front seat, a special window on the world, for viewing the conditions under which weapon systems evolve. They have a unique opportunity to observe over extended periods of time myriad forces at work--the cross-currents of political debate, the sometimes contradictory policy, the conflicting interests, the euphoria of technological success, the discomfort of failure--in short, the panoply of complex technical-economic-political processes, processes which are the weapons acquisition process.

It is thus quite natural that a paper such as this should be a product of a program office. However, it will be recognized that the material is not SAFEGUARD System peculiar, but rather is weapons acquisition process peculiar. The author has drawn upon experiences gained from past associations with the defense industry, think-tanks and weapon system project offices in this attempt to weave a fabric of understanding necessary to any change in acquisition policies. In this regard the reader will find no new and startling evidence supporting radical change but will find, hopefully, new ways of viewing some very old problems. The views expressed are those of the author and are not necessarily those of SAFEGUARD program management or the Department of the Army.

—WAYNE M. ALLEN

ABSTRACT

Adequately managing the weapon systems acquisition process presents one of the greatest challenges confronting Government and industry alike. The general impression today is that this challenge is not being successfully met. The process is marked by raising costs to the buyer and declining markets for the seller. An issue on which there has been much public debate but little understanding is the issue of competition--competition within the Government and between companies in the defense industry.

Prevailing incentive systems, being driven by competition, cause both buyer and seller to respond in ways which yield unrealistically low weapon system cost estimates. A panoply of conditions underpins this phenomenon of downward bias. An understanding of the pre-contract award environment assists in explaining how and why costs grow in the post-contract award period.

The uncoupling of requirements from their associated costs is a contributor to downward bias in cost estimates and is driven by competition and nourished by conditions prevailing in large bureaucracies. It masks the connection between pre-award activities and post-award cost growth.

The incentives exist for ~~the~~ procurement ~~element~~ to establish the most favorable contract negotiating positions based on ~~this element's~~ concept of what a system should cost. This appears to contradict the incentives of the management element to establish for resource allocation purposes the best estimate of what a system will cost. Confounding the cost estimating problem is the incentive of all elements to establish for their systems those costs necessary to remain in contention for limited resources, such resources being what their system must cost.

The winner of the battle of cost estimating philosophies is must cost, decided by the prevailing monopsonistic market conditions. This highly competitive environment of one buyer and many sellers is dedicated to the proposition that costs must be lower. If cost estimating is to improve, if the potential for large cost growth is to be minimized, this environment must be changed.

CONTENTS

I INTRODUCTION

We are reminded from time to time that our national resources are not infinite, that we must exercise selectivity in the allocation of these limited resources. Because resources are scarce and because there are conflicting demands for what is available, it is important to attribute to each demand the most realistic cost possible. Otherwise, resource allocation decisions would not accurately reflect directions desired by policymakers.

Planned defense objectives, indeed national objectives, can be thwarted by cost escalations. Cost escalations cause reappraisals of objectives, losses in forward momentum and preemption of dollars previously planned for other programs. Within the military establishment the essence of the problem of cost growth is that it carries an implicit and probably undesirable change in force composition and delay in fielding technically advanced weapon systems. Said another way, cost growth causes defense planners to become locked into programs which they may have elected to by-pass in favor of other alternatives had an early cost estimate reflected the costs now being faced.

Why do weapon systems ultimately cost much more than originally estimated? Is some cost growth unavoidable? Are there concepts and

philosophies--is there a theory--that might stem the increasing number of horror cases which plague the Pentagon--cases that give a Rube Goldberg cast to the weapons acquisition process?

To be sure the causes, at least the ostensible causes, have been identified and categorized. It is generally recognized that inflation causes costs to rise, that engineering changes, a necessary evil of high technology programs, cause costs to rise, and that schedule changes likewise impact costs--to cite a few of the commonly suggested causes. It is equally evident that initial program cost estimates, those estimates with which later costs are compared, could include forecasted inflation, estimated costs of engineering changes and allowances for potential schedule changes. Such costs could be included when computing the initial cost estimate, but generally are not--at least not to the extent that is possible. Why not?

The reasons why initial weapon system cost estimates, or for that matter estimates calculated mid-way in the weapon's life cycle, do not reflect the fullest cost possible--and therefore do not reflect a closer approximation of later costs--are complex. The reasons are found in the prevailing incentive systems--that combination of rewards, conditions and

constraints which drives individuals and organizations to do the things they do. The reasons are found in the incentive systems implicit in Government procurement (i.e., contracting process), in military command relationships and in the industrial marketplace. There is no a priori reason why cost growth is unavoidable, at least cost growth of the magnitude being experienced. Cost growth, the positive difference between ultimate cost and initial cost, is a function of the prevailing incentive systems, and incentive systems can be changed.

The purpose of this paper is to identify, classify, sort and recombine the terms, processes and philosophies impacting weapon system cost estimating in a manner illuminating incentive systems at work. After setting the stage, the paper explores the phenomenon of downward bias in cost estimating, continues with a contrasting of the differing philosophies associated with cost estimates and concludes with a theory of the root cause of cost growth.

II SETTING THE STAGE

One of the most balanced weapons acquisition discussions presented to date is found in a report by the Committee on Government Operations, US House of Representatives. This Report observed:

> "Each system, whether striving to be born or fighting against cancellation, has its defenders and detractors. There is much at stake in jobs and profits, professional careers, military service prestige, company growth, and community welfare. There are also national defense needs which must be served, however the benefits are distributed. To choose wisely, to manage well, to deal fairly in this complex environment of systems acquisition, are perhaps the greatest challenges confronting Government and industry alike. The general impression today is that these challenges are not being successfully met.
>
> "Too many systems, it seems, have cost overruns, late deliveries, and technical deficiencies in design or performance. Understandably, the systems which will not work as intended, or which cost more than originally estimated or represented, are those which attract congressional and public attention. To many critics cost overruns are the arithmetic of military extravagance, mismanagement, and waste. They depict military and industrial managers as joined in an unholy alliance--the military-industrial complex--mutually profiting at public expense. Those on the defensive in Government and industry invite attention to the complexities of system development and the less controllable

factors in cost growth, such as economic inflation or technical unknowns." 1/

In short, the environment is one of rising costs to the Government, declining markets for industry and much public debate.

Rising Costs

That there has been substantial cost increases cannot be denied; the General Accounting Office's first full scale management report to Congress detailed a net cost growth of $33.4 billion on 61 major weapons systems. Aviation Week presented the following detail:

> "Below are cost details on General Accounting Office's study of 61 major weapons systems. The figures were obtained from the Defense Dept. and verified by GAO.
>
> "The planning estimates are those used by the military departments in initial presentations to congressional committees to obtain program authorizations and funding.
>
> "The development estimates reflect figures used during the time of negotiations with contractors.
>
> "Over $3.2 billion of the $23.9 billion difference between the development estimates and the current estimates was due to changes in quantities ordered.

1/ "Policy Changes in Weapon System Procurement," 42nd Report, Committee on Government Operations, US House of Representatives, Dec 10, 1970.

"Figures are in billions of dollars.

Number of Systems	Planning Estimate	Development Estimate	Difference Between Planning and Development Estimates	Current Estimate Through Program Completion	Difference Between Planning Estimates and Current Estimate
Army—14 systems....	14.9	14.4	−0.5	16.3	+1.4
Navy—32 systems.....	31.5	34.9	+3.4	53.3	+21.8
Air Force—15 systems	37.2	43.8	+6.6	47.4	+10.2
Total—61 systems..	83.6	93.1	+9.5	117.0	+33.4

" 2/

Nor should one assume the $33.4 billion is a final portrayal of cost growth. It is simply the difference between the early planning estimate and the current estimate which includes systems not yet completed. A conservative statement would be that the $33.4 billions growth on a $83.6 billions base is an estimate made at an intermediate point in time and indicative of a trend.

Declining Defense Markets

Net value of new procurement actions (minus cancellations, terminations and other credit transactions) amounted to $38.8 billion in FY-68, $36.9 billions in FY-69 and $31.3 billions in FY-70 or a market decline of about 20% in three years. This, of course, does not tell the

2/ "DOD Urged to Find Cost Overrun Causes," Aviation Week & Space Technology, March 29, 1971, p 21.

whole story. There has been substantial change in the product-mix being purchased with these fewer dollars. Among other reasons for shifting requirements, the Vietnamese conflict has necessitated an allocation of resources to less high technology armaments thereby compounding the marketing problem ofthe major weapon system suppliers.

As if a declining overall market coupled with a shift in product-mix were not enough, "rotational" aspects, i.e., you win some you loose some, of weapons acquisition have continued in evidence thereby further complicating the task of staying alive in the defense business. Table 1 illustrates the rotational nature of the business with sharp gains for some, sharp losses for others. The point is, as the overall defense market declines, companies able to capture significant programs can, for short periods increase their share of the market but at a profound cost to other companies. To not win a major program in a period of shrinking defense expenditures confounded by changing product-mix can be devastating to a major defense supplier.

Public Debate

Every weapon system has its "defenders and detractors." With the continuing illumination of difficulties in weapons acquisition, particularly with respect to cost overruns, the debate has taken on a new dimension. The issue has escalated from a rigorous dialog between knowledgeable people on the merits of a particular weapon system to

TABLE 1

A CONTRAST OF FY-70 AWARDS

WITH FY-69 AND FY-68 AWARDS - TOP TEN COMPANIES*

Company	FY-70 Awards ($ Bil.)	% Change from FY-69 Awards	% Change from FY-68 Awards
Lockheed	1.85	-9	0
General Dynamics	1.18	-5	- 47
General Electric	1.00	-38	- 33
American Tel	.93	+ 2	+ 22
McDonnell Douglas	.88	-18	- 20
United Aircraft Corp	.87	-13	- 34
North American Rockwell, Inc.	.71	+6	+ 6
Grumman Corp.	.66	+57	+ 5
Litton Industries, Inc.	.54	+67	+ 15
Hughes Aircraft Co.	.50	+14	+ 72

*Source: "Companies Receiving the Largest Dollar Volume of Prime Contract Awards," Dept. of Defense, OASD (Comptroller), Issues for FY-68, FY-69 and FY-70.

emotional charges of "unholy alliance" between the military and the defense industry--to suggestions that national priorities be realigned not so much because of any change in the international threat but because defense procurement is a wasteland and we would, therefore, the critics argue, get more for the tax dollar in other programs.

While schedule slippages and less than expected technical performance has received comment, the focus of public debate is on cost increases. The dollar has become the common denominator, and the reasons for cost growth have therefore become key issues with defenders and detractors alike striving to establish in the public mind the "real" issues.

For the most part critics and proponents have based their cases on different issues making difficult any comparative analysis of the strengths or weaknesses in their arguments--an apples and oranges problem. Those in Government point to the difficulties in costing things that have not been invented and stress that cost growth is attributable to myriad reasons running the gamut from internal and controllable causes such as engineering changes and quantity changes to external and largely non-controllable causes such as inflation and Acts of God. By-in-large those on the defensive deal in subjects of what is done, e.g., what R&D program is required, what design is appropriate, what engineering change is necessary, what quantity is needed, which is to say proponents deal in

subjects having requirements, i.e., what do you do, overtones. The implicit view, then, is that it is the "whats," the requirements, that cause costs to rise.

Critics point to alleged inefficiencies in contractor plants, mismanagement and questionable contracting procedures, which is to say critics generally deal in subjects having operational, i.e., how do you do it, overtones. The implicit view here is that it is the "hows," the operations, that cause costs to rise.

There is a subject that is basic to the cost growth question--a subject that bears not only on the hows and whats but on the whos, whens, wheres, and whys as well--a subject on which critics and proponents have taken positions. This subject is all permeating, but because it has been fragmentally treated its impact on cost growth is not well understood and has not been measured. Its impact, not its name, has largely escaped public notice. The subject is competition (or lack thereof) in the weapons acquisition process.

Former Deputy Secretary of Defense David Packard observed in a now widely quoted memorandum that the largest single cause of cost growth is over-optimism in cost estimates for major weapons systems. Mr. Packard stated:

> "This is true both on the part of contractors and the Military Services. Much of this results from the tremendous

> competition for programs among contractors. It is also a product, within the Services, of competition between programs for limited financial resources." 3/

An important element of Mr. Packard's statement is his point that the over-optimism which leads to cost growth is attributable to tremendous competition within industry and within Government.

John Kenneth Galbraith, Professor of Economics at Harvard observed that there was no such thing as competition in the defense industry. Dr. Galbraith said:

> "Another much-featured feature of private interprise is competition. This also is excluded for the defense firms--and more scrupulously, in fact, than under modern Eastern European socialism. In fiscal year 1968 only about one-tenth of all defense contracts were subject to competitive bidding. A shade under 60 percent went by negotiation to contractors which were the only source of supply. Here there was no chance whatever that another firm could horn in on the business. There was, indeed, no market between the firm and the Government. One public bureaucracy simply sat down and worked things out with another public bureaucracy." 4/

Thus, Dr. Galbraith, discussing the subject of competition at essentially the same time as Mr. Packard believes there is no competition. Who is right?

3/ See Deputy Secretary of Defense Packard's Memo for Secretaries of the Military Services, Subject: "Improvement in Weapon Systems Acquisition," dated July 31, 1969 (U).

4/ Galbraith, J. K., "The Big Defense Firms are Really Public Firms and Should be Nationalized," The New York Times Magazine, Nov 16, 1969, p 50.

Richard E. Kaufman, an economist on the staff of Senator William Proxmire's Sub-Committee on Economics and Government, has observed:

> "The myth is that the rules of the market place always assure the most efficient and open and equitable way of producing and trading goods." 5/

Mr. Kaufman says that the reality of defense contracting is that the Government and the contractors are not even trying to follow the rules of the market place and that there is no semblence of bargaining around the table at arm's length. Mr. Kaufman's boss, Senator Proxmire, holds that contractors are reaping huge hidden profits and that a Pentagon policy has institutionalized profiteering. What the Senator and the Economist appear to be saying is that under the rules of negotiated procurements the full force and effect of competitive pressures cease to exist and that the alleged profiteering sets in causing costs to rise, which is essentially what Dr. Galbraith has said.

The defense industry, through its spokesman the National Security Industrial Association, stated:

> "For industry, competition is keen because the overall total of defense business is seldom adequate to support the available capacity of even the hard-core defense contractors, thus forcing companies into a continuous life and

5/ Wilson, George C., "Proxmire and the Pentagon," Armed Forces Management, Feb 1970, p 27.

> death struggle to obtain defense contracts. Defense programs often are of gigantic magnitude, which results in competition more intensely concentrated than is typically encountered in the commercial marketplace. The risk of losing the contract is matched only by winning the competition and signing a contract involving unreasonably high risk." 6/

While this finding resulted from a study conducted in the spring of 1970, the condition had been observed much earlier. Peck and Scherer found:

> "...a more fundamental problem of the weapons contractor is the insecurity of his market position. The rapidly changing requirements of military technology force firms to shift their product lines rapidly....
>
> "A further factor has been the relatively easy entry of new firms into the weapons industry. The advent of newcomers, however, has meant that some older firms have lost their relative market positions." 7/

Implicit in Peck and Scherer's comments is the point that the insecurity of market position drives weapon system contractors to vigorously compete.

6/ Defense Acquisition Study, National Security Industrial Association, July 1, 1970, Washington, D. C., p 3.

7/ Peck, M. J. & Scherer, F. M., The Weapons Acquisition Process: An Economic Analysis, Harvard University Press, Boston, Mass. 1962, p 586.

Thus, Mr. Packard, the Natioanl Security Industrial Association and Peck and Scherer have described an intense competitive environment. Dr. Galbraith and Senator Proxmire hold to the contrary. There appears to be some confusion over whether competition exists or does not exist.

In summary, costs are going up and markets are disappearing. Protagonists on the subject of cost growth are divided into two groups, those who hold that costs rise because of requirements changes and those who hold that operational deficiencies are the villian. An all embracing issue on which there is much discussion but little understanding, many statistics but with little relevancy, and knowledge of impact but not on its direction is the issue of competition--competition in the weapons acquisition process.

III THE PHENOMENA OF DOWNWARD BIAS

Many examples of the too-much-competition vs. too-little-competition debate can be found but the previous discussion suggests the following. If a theory is to be established relative to why cost estimates have gone awry, one must first come to conclusions as to the presence of competition both within and outside of Government and, in a related way, as to the macro-environment in which the defense industry conducts its business.

Competition--The Macro Problem

The too-little competition proponents submit as supporting evidence statistics which show that the dollar value of negotiated contracts regularly exceeds the dollar value of formally advertised contracts. The following table illustrates the type of statistics most commonly presented:

COMPETITION IN MILITARY PROCUREMENT, FISCAL YEARS 1954-68

Fiscal year	Total procurement (billions)	Formally advertised (percent)	Negotiated (percent)		Total
			Multiple sources solicited (competitive procedure)	Single source solicited (non-competitive procedure)	
1964	$28.2	14.4	30.7	54.9	85.6
1965	27.4	17.6	31.1	51.3	82.4
1966	37.2	14.2	35.8	50.0	85.8
1967	43.4	13.4	34.1	52.5	86.6
1968	42.8	11.5	30.6	57.9	88.5

8/ Hearing before the Subcommittee on Economy in Government of the Joint Economic Committee, U. S. Senate, Nov 11, 1968, p 39.

From this data critics deduce there is little competition and what is left is on the wane. Such a statistic reflects a specific point in time--the point of contract award. However, such a statistic may or may not reflect the pre-contract award decisions by companies not to bid or not to accept anything but a negotiated contract. It would seem one could not conclude from this that there has been a lessening of competition. Why?

Such a statistic may or may not reflect the pre-contract award decision by Government that a negotiated (including both multiple and single source solicitations) procurement is in Government's best interest. This, likewise, could not be construed as reflecting a lessening of competition. The final form the contracting instrument takes relates to, if not depends upon, the needs of Government--needs based on the realities of trying to buy things that are ill-defined and in instances not invented. Therefore, how can the percent of total procurement awarded through formally advertised bids prove the existence or non-existence of competition?

Contracting procedures are a means to an end; they are not an environment. Statistics on the percent of formally advertised procurements would not support the too-much-competition proponents if it were in their favor. For example, if all procurement were formally advertised, this would not signify more competition than if all contracts were negotiated. Why? Because where there is one buyer and many sellers, the buyer chooses both the type of contract and how it is to be awarded

irrespective of how many suppliers are clamoring for the contract. In short, statistics related to the percent of formally advertised vs. negotiated procurements neither support nor refute arguments related to the degree of competition in the defense industry. Such statistics are simply irrelevant.

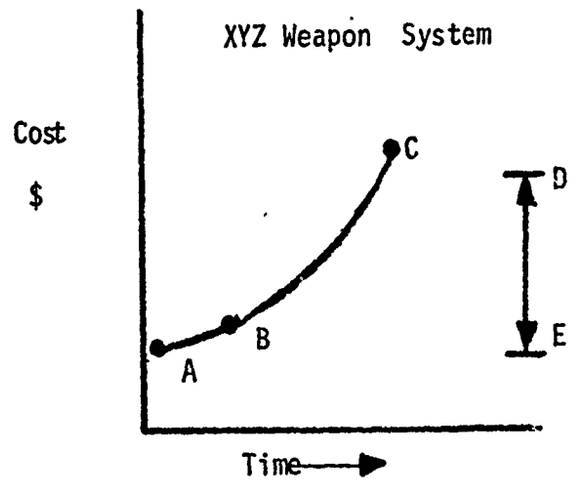
Classical economic theory holds that as competition increases--presumably increasing supply--prices tend to come under pressure and decline. Conversely, as competition declines--presumably decreasing supply--prices tend to strengthen and advance. Thus, implicit in many arguments related to getting the most for the taxpayer's dollar is the belief that all one needs to do is increase competition among defense suppliers and the lowest price will obtain. And, reciprocally, when prices rise the suggested cause is that competition has deteriorated.

Unfortunately, such generalizations have tended to constrain thought to rationalizations which fit the classical theory. Missing are the investigations of how operations of the defense marketplace may differ from or modify the theory. Missing are the investigations of the environment through which weapon systems must pass. Missing is a rigorous assessment of how current acquisition dogma may be creating rather than eliminating the conditions underpinning persistent weapons cost growth.

All that is possible at this time is to suggest a theory, not present hard evidence. I shall set up strawmen of why costs have gone awry. It is in this context that we proceed.

***

Competition is the macro-problem, competition among defense companies and competition among Government agencies. Contrary to classical theory it is grinding competition that is driving costs up--not down. Costs are being driven up when the problem of cost growth is viewed in the usual way. The problem of cost growth is usually viewed as illustrated below:



Point A is the final planning estimate used by military departments in initial presentations to congressional committees to obtain program authorizations and funding. Point B is contract award (cost-plus type contracts).* Point C is final cost experienced on the program. Distance DE is the amount of cost growth.

A suggested reason why the problem is viewed this way is that point A is probably the first instance of a public record on a system's estimated cost. This, then, becomes the point of departure. Point B is the point of contract award, the point at which statistics are gathered by the too-little-competition proponents. Defenders and detractors alike are

*This is not to say that cost growth is peculiar to cost-plus contracts. Fixed price contracts experience growth from engineering change proposals and quantity changes. This is to say that cost-plus contracts is the general instrument the weapons acquisition process employs and returns to on failure of other contract types.

looking from A to C when offering their respective reasons for cost growth, detractors saying DE is caused by profiteering, mismanagement and extravagance, defenders saying DE is caused by engineering changes, quantity changes, support changes, schedule changes, unpredictable changes, economic changes, estimating changes, contract incentive changes and contract cost overruns.[9/]

These reasons for cost growth are, in a broad sense, not causes as would first appear but are effects--effects stemming from a highly competitive environment. Or viewed another way, as a heart attack may be the immediate cause of death of a patient having a long history of arteriosclerotic heart disease, these reasons can be considered the immediate cause of cost growth in a process impaired with a more fundamental and long term malady. Or viewed still another way, these reasons are the tip of the iceberg with the competitive forces of economics, technology and politics being that portion below the surface.

These suggested reasons for cost growth are effects of an environment existing in the period pre-Point A. Point A is as much an ending as it is a beginning. It is at Point A , or at least in time period AB, that pre-contract award activities cease. It is the environment pre-Point A that gives rise to the events of the post-Point A period. Thus. a complete understanding of the cost growth problem

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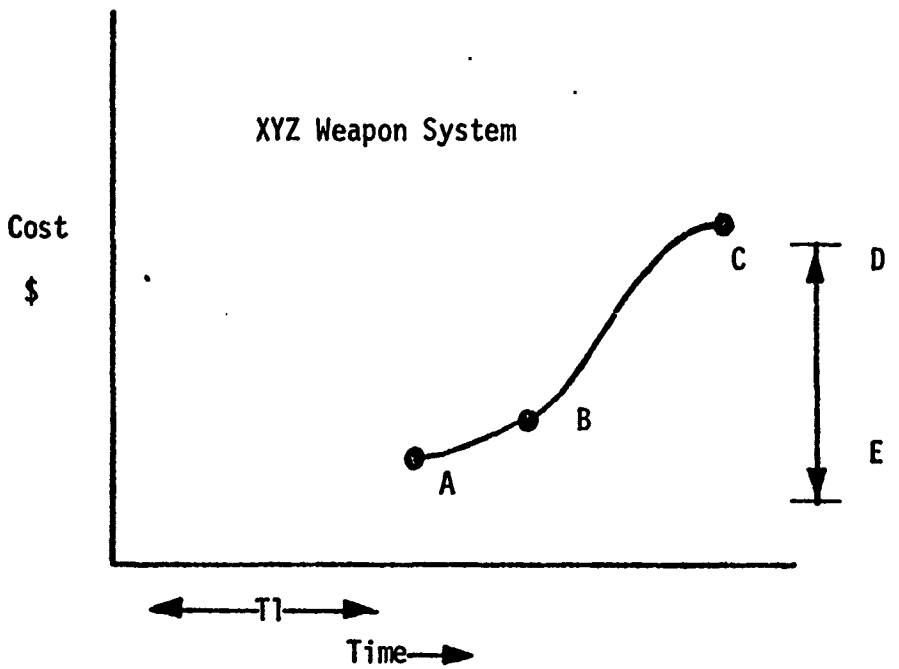
9/ See Deputy Secretary of Defense Packard's Memo for Secretaries of the Military Departments, subj: "Cost Growth Definitions" dated Aug 5, 1970 (U).

can evolve only after study of the pre-award environment. The context of the complete problem may be, therefore, established as follows:



The period of interest is T1, that time spectrum within which economic (supply/demand), political and technological forces come into play relative to a given major weapons acquisition. What are the characteristics of this pre-award environment and how does it contain seeds for cost growth post-award?

The pre-award environment is characterized by intense study and planning on the part of Government and industry in an attempt to conceptualize systems whose salient attribute is that they promise a performance advantage over systems believed to be in the hands of unfriendly nations. Industry and the military establishment bring their collective knowledge together to formulate alternatives for combating the threat, the military contributing threat inputs, industry contributing technology inputs. Thus, starts the dialog and the almost infinite number of iterations between threat and counters to the threat. Each successive iteration yields more questions, and demands more expertise thereby creating increasing contractor involvement. The game is seeking the best answers, the stress is on technical innovation. The early environment does not (and should not) include cost thresholds which, if exceeded, would cause thought on the problem to cease.

As potential technical solutions begin to firm (generally after both formal and informal involvement of substantial numbers of contractors), the realities of resource demands are faced. While it still may be a year or more before contract award, various sets of contractors begin to "choose-up sides" and the pressure mounts for cutting costs of designs which are still more theory than reality. The pressure is felt by industry and Government agencies alike. Let us therefore consider both out-of-house and in-house aspects of the problem.

Industrial Competition. The "refinement," perhaps skeletonizing is a more descriptive term, of designs is probably the best known way of meeting

competition. Costs of only the bare essentials, i.e., no contengencics, are presented. Less well known but probably more contributory to substantial cost estimate reduction in the pre-award period is the practice of policy pricing. Policy pricing is considering factors, when formulating a cost estimate, which relate to the probability of an organizational entity winning business--factors over and above the land, labor and capital necessary for the job. The term "organizational entity" is used because policy pricing is not limited to one company competing against a host of other companies. Intense competition between divisions within a company and even between departments within divisions, results in numerous opportunities to shave cost estimates as they progress up the line. The corporate headquarters is not the sole element to exercise policy pricing; it is but the last.

How can there be substantial competition within a company? The defense industry of necessity is at the forefront of a rapidly expanding technology. As knowledge has expanded downward, i.e., in ever increasing detail, many common denominators have evolved, which is to say, a given problem may now be solved in more ways. For example, in past years companies have organized along functional lines as in having an electrical products division and a mechanical products division. With the advent of multidiscipline technicians, a product of our expanding technology, both divisions now compete with each other as electromechanical divisions. Nor does it stop there, previously widely

separated technologies are now providing answers to the same problem. For example, power sources are now being derived from mechanical, electromechanical, chemical and electrochemical technologies. Being neither technologically nor managerially monolithic, defense companies incur a type of intra-company competition probably more severe than found in any other industry. When several multi-divisioned aerospace concerns become involved in a particular problem--when both intra- and inter-company competitive forces are at work--the potential for cost estimate cutting becomes quite high.

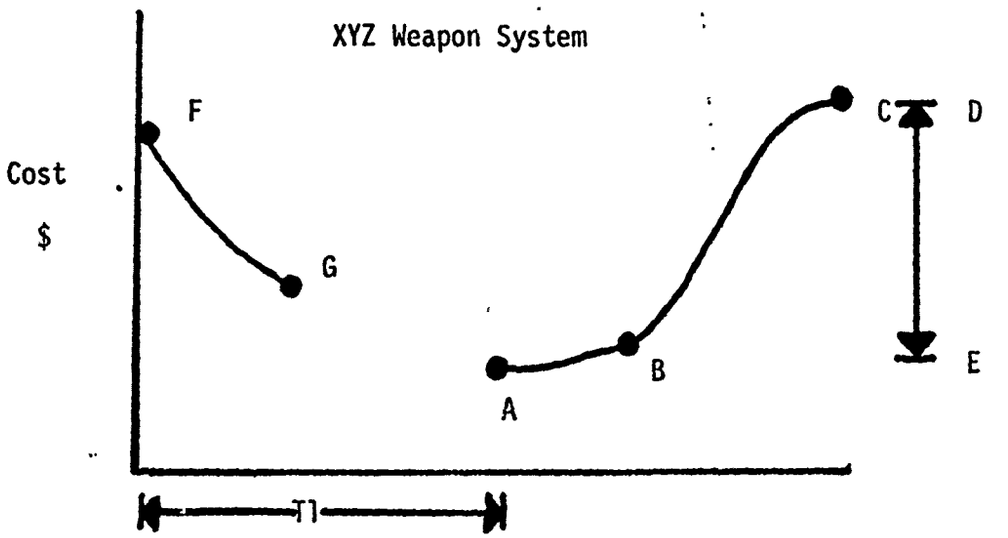
It is a fact of life that the practice of policy pricing is well ingrained in defense industry costing procedures. Less we too quickly become critical of industry for this practice it would be well to consider the following:

> "The defense industry is unusual in that it serves essentially one customer. This customer's procurement policies establish the defense industry environment. Therefore, if we are dissatisfied with the contractor's practices and performance, we need to examine more closely the impact of Government policy on the defense contractors' method of operation." 10/

Government policy is to aggressively stimulate competition among defense suppliers.

10/ Anderson, R. M., "Anguish in the Defense Industry," Harvard Business Review, Nov-Dec 1969, p. 162.

Competition, yet unrecorded as a quantitative matter, drives costs down in the pre-award period. This activity may be illustrated as follows:



Point F is the first cost estimate for a given concept, generally compiled at an intermediate level in a contractor's organization.
Point G is the first time the estimate is discussed with a degree of corporate sanctity.
Curve FG is the cost reduction attributable to industrial competition.

The missing portion of the pre-award time frame will be addressed next.

Government In-House Competition. The most oft-repeated exclamation heard in military planning and funds programming circles is: "That will never sell!" This statement characterizes the in-house competition for resources and the ensuing activity of forcing weapon system costs to fit allocated budgets.

The existence of in-house competition is generally recognized. Perhaps less well understood is its all pervasive character and impact on weapon system cost estimates. The essentials are captured in the following excerpts:

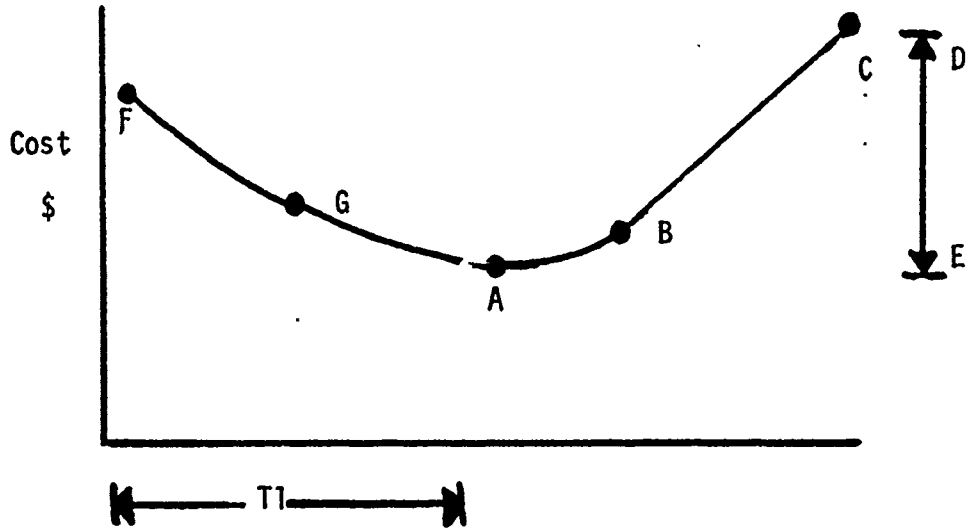
> "Within DOD itself, competition is a very active force. This is reflected in DOD's drive to stay ahead of our potential enemies by fielding weapons which incorporate the latest possible technology; in DOD's relationships with other governmental departments; in the efforts of the Military Services to protect and expand their respective roles and missions and to obtain a larger share of the defense budget; in the relationship between the Military Services and the Office of the Secretary of Defense (OSD); and in the competition among the branches, commands, arsenals, yards, centers and laboratories of the Military Services.
>
> "Competition among the Military Services for available budget dollars increases the prevalent overoptimism which works against realistic technical assessment and planning based on realistic cost and schedule estimates. OSD's responsibility for determining the allocation of resources is made most difficult because the military services naturally are inclined toward spirited promotion and defense of their

> own convictions. OSD, then, must maintain an effective and essential analysis capability to ferret out the soft spots, weigh the risks, perform trade-off studies, and evaluate cost-effectiveness among the programs advocated by the Military Services." 11/

As there are many echelons in industry each providing the opportunity to cut cost estimates, there are likewise many echelons in Government thru which cost estimates must pass. The competitive environment is such as to lend a decided bias to the review process. The bias is a downward revision in cost estimates.

Thus, the action officer level in the military services receives a "very preliminary" estimate of costs from defense contractor personnel--an estimate that has already had a degree of policy pricing applied. The estimate begins to be placed before increasing numbers of administrators in the Government hierarchy and judgments begin to be made relative to how well it fits. For reasons mentioned, it does not fit very well in the early iterations--it costs too much. Downward adjustments are made and the GA portion of the curve is completed:

11/ Defense Acquisition Study, op. cit., pp 3,4.



Curve GA is the cost reduction attributable to Government in-house competition.

That contractor and government personnel respond to their environment thru the form of gamesmanship suggested here is a matter of theory. Of interest are selected comments by former Secretary Packard on his departure from the Defense Department:

> "I still think that probably the most important factor in the relationship between the Services and the Department and the defense industry is for them to play it straight with each other and to address these problems objectively and I believe we have a much better attitude toward that end now than we had in the past. I don't want anyone to go under the illusion there will be no cost growth in the future but I think it's very likely to be under better control in the future than it has been in the past." 12/

12/ From a news conference with Secretary Laird at the Pentagon, 13 Dec 1971 on Secretary Packard's resignation as Deputy Secretary of Defense.

Requirements Uncoupling--the Micro-Problem

Up to this point it has been suggested that grinding competition of both the internal and external variety cause costs to rise post contract award because such costs were driven artificially low pre-contract award. This is a rather simplistic explanation. Why have our policymakers not identified this cause and effect before now?

The understanding of the problem, and therefore its explanation is compounded by the competition related, probably competition driven, issue of costs becoming detached from the requirements with which they are originally associated. This phenomenon is termed requirements uncoupling. And, requirements uncoupling tends to mask the connection between grinding competition and cost growth.

Clearly, cutting costs concurrently with cutting requirements is a management option. And, if it were possible to keep costs and requirements coupled, the potential for unpleasant surprises could be reduced. That there is a certain cake-and-eat-it-too demand, i.e. desire for many requirements but few costs, is unmistakable however. If requirements impact of cost cuts were clearly illuminated some systems would simply cease to be viable, the threshold of minimum effectiveness having been violated. However, the field of cost-effectiveness is subject to much wizardry and it is rather too much to expect that system champions would conclude, on re-evaluation, that budget cuts now force an elimination of their systems. The foot is simply cut to fit the shoe. Budgets are cut but the requirements live on, at least to the day of reckoning.

Requirements of both a technical and operational type--which is to say, performance and deployment requirements--tend to become uncoupled from their associated costs in the course of researching, producing and deploying major weapon systems. This disassociation may also be referred to as the point estimate problem. It is referred to as the point estimate problem because reasons for uncoupling generally relate to the fact that weapons systems requirements are fluid until well into the system's life cycle while, in contrast, associated costs are almost always quite specific. This is to say there is a singular or "point" number which tends to become institutionalized. Requirements remain variable and costs tend to become uncoupled for a variety of reasons we shall explore. But, first we need to know more about the point estimate and why it evolves as the estimate used by the institution.

Since, by definition, a point estimate cannot convey a range, it is highly inflexible when conditions demand flexibility. A point estimate is a singular cost number presented for a singular set of requirements, conditions, criteria and assumptions both explicit and implied. There are two facets to the point estimate: 1) it is a singular cost number, and 2) it represents a singular design. Thus, the context of the point estimate may be illustrated as follows:

Weapon System Cost Estimates

Classified as to Probability of Remaining
Coupled with Requirements

System Design / Cost Estimates	Single	Range (of designs to satisfy a Mission)
Single	Point Estimate (Low Probability)	Cost estimate as an average of a range of designs Treats uncertainty in designs (moderate probability)
Range	Cost Range for a Design - Treats Uncertainty in Costs (Moderate Probability)	Cost range for a range of designs - Treats uncertainty in designs and costs (high probability)

The point estimate evolves early in the life of a weapon system perhaps as early as the initial system studies which preceed the preliminary concept papers. And, while the specific deployment configuration may be months, even years away--while the technical and performance characteristics are still quoted in ranges and are most general in nature--a cost estimate is nevertheless presented, indeed demanded by

the weapons acquisition institution. The cost estimate presented is most generally of the point estimate variety thereby setting the stage for requirements uncoupling.

It is possible to suggest several reasons why the point estimate evolves as the estimate used by the institution. The reasons may be categorized in terms of who is involved, industry or government.

Industry - Procedural Reasons - For the most part, the industry staffs that cost the always ill-defined initial weapon system concepts are the same staffs, i.e. finance and accounting, that pull together the responses to Request for Quotations (RFQs). Their approach, which has its roots in the Armed Services Procurement Regulations (ASPR), is based on such considerations as direct labor hours, overhead rates, purchased materials and major sub-contract efforts and so forth. Also implicit in the approach are the constraints imposed by the ASPR's such as those related to restrictions on the use of contingency allowances. This approach has two characteristics. First, it demands a specific design, in some detail, before the staff can proceed with the estimate--design details that will probably have little relationship to what eventually evolves. Second, because the approach is necessarily laborious, time and money constraints preclude considering a range of designs. Thus, a specific estimate for a specific design evolves. Parametric cost estimating techniques are generally not sufficiently well understood or accepted by such staffs to be applied with confidence--with the resultant use of tools which are at best ill-suited for the task at hand.

Industry - Legal Reasons - Industry's posture is that all dealings with the Government have contractual, and therefore legal, overtones. The frame of reference is in terms of specifics, not ranges, because one contracts for a singular price (at least initially) not for a range of prices. So deeply embedded is this principal that companies have been known to preclude certain of their activities such as system analysis and advanced design departments from generating cost estimates (although in some instances admirably equipped to do so on a parametric basis), demanding instead that all cost estimates flow through finance and accounting and legal channels. This, of course, returns one to the ASPR's and the requirement for a specific detailed design.

Government Planning, Programming and Budgeting Reasons - DOD staffs involved in weapon system PPB procedures include in their documents point estimates because that is the established convention. One reason the established convention remains established is that staffers presume, perhaps implicitly that those responsible for the estimate, i.e., the source, had previously resolved cost, design and deployment issues and that this resolution represents a concensus or "best" estimate. Because of the nature of a point estimate and the possibility that 1) the point cost is not a mid-point or valid representation of range of costs associated with the point design, and 2) the point design is not a mid-point or valid representation of the range of designs capable of

satisfying the requirement, the validity of the presumption may be challenged. It is at best a chance occurrence that the point estimate included in programming documents is a "best" estimate.

Another reason the established convention is not changed is the mechanical convenience of dealing with point estimates. Point estimates can be added and subtracted from larger aggregates with ease. A cost estimate expressed as a range is difficult to administer, akin to adding Roman numerals. One former Deputy Assistant Secretary of Defense viewed the problem this way:

> "The requirements of the programming system often make it mandatory that a Service submit point estimates during concept formulation when I am sure a range of values would give a more realistic picture of a new system's resource requirements. If you wish, point estimates required by SARs and DCPs early in the acquisition process could be footnoted with the ranges of values felt to characterize these projections. It would also be useful to cite the factors to which the uncertainty in the cost estimates can be attributed." 13/

Government Organization Reasons - Organizationally, major weapon systems are managed in accordance with military doctrine. This is to say, field agency commanders relate to higher headquarters through the chain of command through the mechanism of establishing "command positions." On cost matters, a range of costs, vis-a-vis a point estimate, is the antithesis of a command position carrying the rather dire inference a commander can not make up his mind or is

13/ Rice, Donald B., "Use of Statistical Techniques in Cost Estimating," Memorandum for Assistant Secretary of the Army (FM) from Deputy Secretary of Defense (RA), 6 Feb 70 (U).

unable to propose a specific program. Thus, the point estimate has the attribute of eliminating the spectre of non-precise action.

Thus, it may be said that from the defense industry's standpoint there are procedural and legal reasons and from the Government's standpoint there are budgeting and organization reasons why the point estimate evolves as the estimate used by the weapons acquisition institution. It is now appropriate to reflect on the adequacy of point estimates.

Adequacy of Point Estimates

Does the point estimate breed trouble and, if so, how? It is submitted that the weapons acquisition institution tends to loose sight of what "cost" really is. Cost is a proxy. In weapon systems it is a proxy for speed, range, payload, resolution, power, quantity, time, etc., which is to say cost is a proxy for capability-- capability in terms of performance and deployment configuration. Cost, because it is a proxy, is a dependent variable, dependent upon what it is we are buying, i.e., requirements. It is a truism then that if costs become uncoupled from requirements they become meaningless, unreal numbers. Unfortunately, and for a variety of reasons which shall be discussed, costs tend to become uncoupled from requirements. And, the point estimate, it will be shown, is the lubricant that speeds the uncoupling process.

Point estimates tend to become uncoupled from requirements for a variety of reasons. The reasons may be categorized as follows:

Functional (lateral) reasons. Activities of personnel associated with the budgeting process within the weapons acquisition process are governed by detailed instructions relative to the categorization of costs, assignment of budget codes, appropriation titles and other practices and procedures that have evolved over decades of budgeting for military programs. The budgeting function is primarily concerned with the administration of Congressionally approved sums of costs. The interrelating of technical details with budgets tends to be sporadic. Subjects such as marginal cost of performance improvements tend not to be addressed. Generally speaking, mechanisms do not exist for budgets to be anticipatory--for budgets to reflect technical (as opposed to command) knowledge; budgets are instead reactive. And, depending on the distance (physical, professional and/or procedural) between those responsible for the engineering function and those responsible for the budgeting function, the lag time required for budgets to reflect engineering decisions may be extensive. If those associated with resource planning and programming worked with cost ranges rather than point estimates, the propensity to deal in numbers

for numbers sake might be reduced. To answer the question, "Why does that program range in cost from $1.0b to 1.5b," requires a different kind of understanding than answering the question, "Why does that program cost $1.0b?" The answer to the latter question is generally: "Because it includes A for $0.5b, B for $0.3b, and C for $0.2b," an accounting type answer. The answer to the former question would have to deal with uncertainty and therefore the causes of uncertainty -- thereby requiring a technical answer. Working with cost ranges could have the salutary effect of bringing the functions together. The point estimate perpetuates accounting type answers, the schism between budgeting and technical functions and thus the uncoupling of costs from requirements.

Hierarchial (vertical) reasons. There are, in Government, myriad administrators at all levels in the weapons acquisition process. With a few notable exceptions the higher one goes the greater the gravitation to the language of costs and budgets, away from the technical language of requirements. Administrators at all levels are comfortable in discussing dollar costs. Costs, like the weather, can be talked about by everyone.

Administrators are much less comfortable in discussing such subjects as ferrite phase shifter technology as it impacts radar costs, specific impulse as it relates to missile costs and instructions per

second as it impacts data processor costs. Administrators are also much less comfortable in discussing threat parameters such as size of arriving force and attack tactics and the impact of these parameters on quantities and types of hardware we must procure. Administrators, having before them a point estimate, appear to derive a comfortable feeling that such a number is in the ballpark, perhaps simply because it has been reduced to writing. The point estimate precludes any potentially salutary anguish that would derive from a cost range. The higher one goes the easier it is to talk costs, the proxy, and the more difficult it is to talk requirements, the substance.

Tremendous imbalances exist within the Government hierarchy between "knowledge" of costs and knowledge of the shifting technology and threat characteristics on which cost is based. Until these imbalances are corrected, which is to say until knowledge of requirements, of specific capability, is coupled with costs, the potentiality for uncoupling will remain quite high. Point estimates perpetuate these imbalances.

Time reasons. Procuring a major weapon system is an incremental process, incremental in terms of pieces of the system procured over pieces of time, generally expressed as fiscal years. For any given weapon system there is a logical, but theoretical, optimal time phasing of system requirements. The optimal situation is subjected to the forces which apply to annual budget determination and undergoes change. Annual budgetary considerations tend to dominate with incremental requirements being patched in as best as possible. As in any patching

endeavor, some of the pieces do not quite fit and on occasion pieces get lost to be found again, hopefully before deployment. Time, in the form of annualized budgets, causes requirements to uncouple from point type costs which cannot accommodate the flexibility required in inter-year programming as costs become an end unto themselves in the annual budget cycle.

Size-of-Government reasons. A point estimate tends to become uncoupled from requirements simply because of the physical numbers of people and functions that become involved in the weapons acquisition process. Weapons design, development, and deployment is a dynamic process requiring frequent change. While previously cited functional and hierarchial reasons contribute to costs lagging requirements, the sheer magnitude of Governmental involvement creates its own force in causing costs to uncouple from requirements. The weapon system project office (WSPO) concept has helped to streamline the decision making process and otherwise shorten lines of communications. However, the many functional areas in which Government becomes involved, e.g., the "ilities" - reliability, producability, availability and maintainability, and which proliferated pre-WSPO are tending to surface within the WSPO. Thus, the possibility exists of creating within the WSPO's in microcosm, the very multiplicity of functional areas the WSPO concept seeks to eliminate. Thus, "size-of-Government" may be a misleading categorization; numbers and types of functions, i.e., function proliferation, may be more descriptive of this particular force. A point estimate lacks the flexibility to accommodate in-house costs attributable to function proliferation.

Procedural reasons. As was previously covered, there are procedural reasons why the point estimate evolves. There are also procedural reasons why point estimates cause uncoupling.

Uncoupling takes place when an estimate must reflect procedures promulgated for all procurements and tailored for none. An example is OSD promulgated inflation rates designed to assure uniformity in the application of inflation costs to all programs. Inflation, however, varies between industries and between classes of labor and materials within industries. As different weapon systems make use of differing amounts of labor and materials in differing industries it is a chance occurrence that requirements of a particular system would have current dollar costs which reflect inflation rates approximating those set for all systems. Another example relates to the practice of specifying that either no contingency cost may be included or an arbitrary fixed percent contingency allowance may be included in point estimates. A program having relatively high risk requirements, i.e., unknown unknowns, can be rather dramatically uncoupled from costs through such procedures--procedures that do not recognize risk differentials existing between weapon systems. A point estimate, as opposed to a range, cannot overcome the bias injected by procedures and, therefore, perpetuates a cost not truly reflecting risk differentials.

Summary

There are two major, interrelated factors bearing on an understanding of cost growth in the weapons acquisition process, competition and requirements uncoupling. Competition cannot be viewed solely at the time of contract award but must be viewed over a spectrum of time preceeding contract award. The complexities of the pre-contract defense marketplace must be understood if an understanding of the root cause of cost growth is to result. The many suggested reasons for cost growth are not causes but are effects--effects of, by-in-large, competition and requirements uncoupling.

Competition within and between corporations and between Government agencies cause estimated costs to decline pre-contract award. The point of contract award is approximately the point of lowest estimated cost. Requirements uncoupling tends to keep estimated costs in the vicinity of initially contracted costs for a period thereby masking the connection between pre-award activities and post-award realizations. However, pressures created during intense pre-award competition activities must be eventually released with the sharpness and magnitude of the release being generally proportional to the intensity and size of these pre-award activities.

Requirements uncoupling is aggrevated by the inflexibility of point estimates. Point estimates, rather than a range of cost, evolve because of industrial procedural and legal reasons and Government PPBS and organizational reasons. Point estimates contribute to the uncoupling of costs from the substantive requirements they should be reflecting. They contribute to this uncoupling because of functional, hierarchial, time, size-of-Government, and procedural reasons.

IV SHOULD COST/WILL COST/MUST COST

The subject of cost estimating major weapon systems may be broached from three directions. The direction chosen by any given individual at any given point in time is a function of that person's political persuasion*, technical capacity and inclination towards the pragmatic. These three directions--what a weapon syscem should cost, what it will likely cost and what it must cost to stay in contention--epitomize the cost estimating problem and therefore the cost growth problem in the Department of Defense today.

A discussion of the underlying philosophies and, in a limited way, the mechanics involved will serve to put in perspective current Government policy and, importantly, provide insights relative to the adequacy of that policy.

Should Cost

Should Cost is a cost estimating philosophy and, within Department of Army at least, it is a specific program. As a philosophy, Should Cost holds that the impetus of price competition to produce efficient practices found in the commercial marketplace cannot be relied upon to produce similar practices in the defense industry. The philosophy continues:

*Degree of Government involvement in the internal affairs of defense companies is considered a political issue.

"As price competition becomes less active, as in the case in many defense contracts, there is less pressure for this efficiency and, in the case of a sole source procurement, the pressure practically disappears. Depending upon the contractor's several motivations, he may or may not be fully efficient in a sole source situation. The Government must therefore insure that the contract price negotiated represents what the contractor should incur in performance of the contract assuming reasonable efficiency. To determine what costs are reasonable, the Government must make a detailed cost analysis of the contractor's performance plans to assure that the contract price represents what the performance should cost if the contractor were efficient." 14/

Implicit in the Should Cost philosophy are five fundamental presumptions:

* Defense contractors as a group are generally inefficient producers.

* Defense contractors' proposals are high relative to the price that would prevail if they were efficient producers.

* Government analysts are better trained, more knowledgeable, more objective and/or more dedicated to achieving more for the defense dollar than are their counterparts in the defense industry.

* Government analysts conducting Should Cost studies will identify inefficiencies and use the findings to support Government contract negotiating positions.

* Should Cost studies will improve the weapons acquisition process by achieving lower costs.

14/ From remarks of Dr. J. R. Fox, former Assistant Secretary of the Army, (I&L), before the Sub-Committee on Economy in Government of the Joint Economic Committee, U. S. Congress.

In short, the Should Cost philosophy holds that competitive forces cannot be counted on to achieve attainable efficiency and economy of operation because such forces tend to become non-existent and that, therefore, the Government must determine and attempt to negotiate what a program should cost if the contractor were efficient. Implicit in the philosophy is the belief that costs should be lower.

As a program within Department of Army, should cost is at once a methodology and an activity. The methodology employs industrial engineering, accounting and general business management skills to evaluate a defense contractor's manufacturing operations, accounting procedures, cost estimating systems, purchasing systems, make-or-buy decisions, organizational structure and management controls. The activity employs Government personnel to conduct investigations called "Should Cost Studies" within the contractor's plant.

The purpose of a specific Should Cost study is to compile data on which to base a Government contract negotiating position. This data serves the purpose of challenging a contractor's mode of operation including his management and production practices. Implicit in this activity is a feeling there is a need to redress the imbalances in bargaining positions, namely the placing of the Government in a more knowledgeable position to intelligently debate cost proposals.

Should Cost studies are currently limited to selected major procurements. Past Should Cost teams have consisted of approximately 20

members and are involved in a study for three to four months. The cost of a study is substantial and is the reason for limiting them to major procurements.

Will Cost

Will Cost is an estimate of the ultimate cost of a weapon system to the Government. Will Cost estimates are characterized by a heavy reliance on relevant previous Government procurement and operational experience. Such experience reflects the panoply of conditions, e.g., technical changes, requirement changes, inflation, etc., implicit in ultimate costs. A Will Cost estimate attempts to provide costs that will stand the test of time by anticipating, through macro-evaluative techniques, the conditions causing cost growth. Will Cost estimates result from the view that, from an overall resource allocations standpoint, the best estimate for any given weapons system program is the one requiring least modification, irrespective of any officially sanctioned reasons for cost growth. Will Cost, by definition, is not constrained by accounting procedures, e.g., limitations on cost contingency allowances, agency practice, e.g., rules governing military construction cost estimates, departmental policy, e.g., standardized forecast inflation rates or any other mechanism working to constrain an independent, professional best estimate of what a given system will eventually cost.

Professionalism is an important aspect of the Will Cost philosophy. Coming on the scene in the last ten years or so have been increasing numbers of technicians applying tools grounded in statistics and evolving from such diverse activities as econometrics and biomedical research. These analysts working with generally inadequate data bases and sometimes hostile audiences ("Don't rock the boat" and "We have a number, we don't need another") are attempting to determine what weapon systems most likely will cost. They attempt to maintain an independent posture while applying the tools of logic and analysis, particularly parametric analysis. The use of these tools is captured in the following passage:

> "As you know, estimates for new weapon systems acquisition costs are either derived from detailed, grass root calculations (the industrial engineering approach) or based on relationships between more aggregate components of system cost and the physical and/or performance characteristics of the system. These relationships should be derived from cost histories on prior programs. The latter method is often called the parametric approach. It is clear that, during the early phases of the acquisition process, only limited design information is available and considerable uncertainty surrounds both this information and whatever planning data is available on how the new system will be developed and produced. Nonetheless, cost estimates must be made. Both the fact of limited and uncertain information on which to base estimates, and the use to be made of these cost estimates, strongly suggest the employment of parametric estimating procedures. The parametric approach is particularly suited to making estimates based on limited physical and performance information.

> "At later stages of the acquisition process, detailed contractor proposals are prepared. Sufficient data then becomes available to allow the use of industrial engineering cost estimating procedures. However, continued use of parametric or partially parametric methods should serve as a check on the engineering cost estimate. This is particularly true when the required performance characteristics of the new system are considerably beyond those achieved by previous equipment or when a development program incorporates several technological innovations. The historical systems used as the basis for parametric estimates will each have experienced the uncertainties and associated setbacks characteristics of high performance hardware development. It is important to note that such parametric estimtes are not recommended for program control purposes, but rather as a means of providing service and OSD management with the most probable resource impact of alternative programming decisions." 15/

It is professionalism, the drive for objectivity and the rejection of unsupported cost estimates irrespective of the weight of command approvals, that characterizes the Will Cost estimate and the conflict it engenders.

Must Cost

There is a school of thought which holds that the matter of which comes first, a contractor's estimate of weapon system cost or the Government resources likely to be available, is a chicken or the egg situation--A sort of Parkinson truism that the cost of a weapon system will be the amount budgeted for it.

15/ Rice, Donald B., Op. Cit.

R. M. Anderson writing in Harvard Business Review observed:

> "The contractor learned to work with particular elements of the services, helping them define their requirements and obtain initial funding. The contractor then agreed to do the job on a cost-plus-fixed-fee basis for whatever cost and in accordance with whatever schedule the service element thought necessary to get the contract approved at higher levels." 16/

The amount to get the contract approved becomes what the program must cost. Must Cost, as a class of cost estimates, is strongly influenced by the realities of available or estimated to be available resources. Point estimates make possible the exercise of a Must Cost philosophy while cost ranges, because of implied uncertainty, are generally incompatible with, and would inhibit, the associated legislative process. Must Cost estimates reflect, to a degree, the recognition that there are degradations of thrust and emphasis influencing R&D, investment and operating requirements in all weapon systems. In periods of particularly constrained budgets, Must Cost estimates are based on (1) minimized requirements and maximized risk, (2) nominal requirements and nominal risk but minimized annual cost and less than optimized total cost, or (3) some combination of 1 and 2 above. Thus, Must Cost estimates within the Government are characterized as being funding-strategy oriented and are philosophically related to those defense industry cost estimates resulting from the competitive practice of "policy pricing."

16/ Anderson, R. M., Op. Cit., p 162.

Imbalances between technological realities and funding realities lead to substantial cost understatements. It is not a characteristic of Must Cost estimates that they would approximate the ultimate cost eventually experienced. These estimates reflect what the weapon system Must Cost if it is to survive as a contender for limited appropriations.

Philosophies in Conflict

The Should Cost philosophy has the admirable goal of obtaining for the Government optimal efficiency in contractor operations. However, as a practical matter there are some difficulties.

The buyer is prepared to tell the seller how the seller should conduct his business. The buyer, by virtue of almost unlimited access to the sellers' records, will make judgments which enure to the buyers benefit, the expressed purpose of Should Cost studies being to improve the buyer's negotiating position. The sellers will not object, the taint of a non-cooperative attitude is tantamount to being stricken from the bidder's list. The sellers also know they have recourse through the medium of the Cost Plus contract, which is to say, if the managing and producing efficiencies the buyer said <u>should</u> have materialized do not, the seller presents a bill for the difference. While this is an oversimplification, the fact remains that under Cost Plus contracting procedures the buyer generally assumes responsibility for most of the costs. Thus,

the claims we are hearing today for cost savings arising from Should Cost studies may be premature. It remains to be seen whether costs "saved" by virtue of such studies stay saved over the life of the procurement.

The up-shot of Should Cost activity is to "lower" costs, i.e. lower management's perception of costs, in the near term. Thus, Should Cost is compatible with Must Cost, both philosophies dedicated to the proposition that weapon systems simply must cost less--an implicit concept which is the phenomena of downward bias.

Must Cost is perhaps more direct. It frequently holds to the initial estimate, the one provided Congress, with great tenacity. These early cost estimates tend to become sacrosanct through the mechanisms of the highly visible budget and five-year defense plan. The NSIA observed:

> "The early estimates go into the DOD planning machinery and tend to become cast in concrete. The Congressional committee hearings bring these estimates to the attention of the Congress, and the Military Services are reluctant to propose revisions thereafter. These unrealistic cost estimates also become known to prospective contractors who, in turn, are wary of challenging them because of competitive and customer relations considerations. Thus, the Military Departments and competing contractors feel constrained to continue to be unrealistically optimistic in support of original planning estimates." 17/

The incentive system for weapon system managers and their subordinate staffs rewards for holding the cost line. Congressional committees extract from acquisition managers what is tantamount to a personal pledge that costs will not rise, the inference being that as a manager you should have your costs under control. Thus, Congress also has a role in perpetuating Must Cost estimates.

17/ Defense Acquisition Study, Op. Cit., p. 15.

With the passage of time the difficulty of living within the early Must Cost estimate becomes painfully apparent. Weapon system managers undertake actions to hold the contractor's "feet-to-the-fire." Such actions include generalized dollar cuts, on occasion related to reduction in requirements and/or postponement of parts of the program. Such actions probably result in an overall increase in risk, but as risk is difficult to quantify the impact goes largely unnoticed. These are at best delaying actions, delaying the day of reckoning.

Feet-to-the-fire costs need not be a sub-set of the Must Cost philosophy as implied above although imposition of the feet-to-the-fire technique tends to be more necessary when original cost estimates evolve from the Must Cost philosophy. Feet-to-the-fire costs are basically managerial target costs. As dollars are the most widely used control mechanism, a practice of minimizing estimates of future costs has evolved as a management technique for attempting to impress contractors with the continuing need to produce more for less and in a shorter period of time. In the day-to-day weapon system management continuum, holding a contractor's feet-to-the-fire has the double advantage of stressing cost awareness on the contractor's part as well as keeping the weapon system manager alert to soft areas and areas that he must consider eliminating altogether if further pressure is exerted. Thus, when used this way, feet-to-the-fire costs imposed on contractors represent a legitimate managerial technique.

Problems arise when weapon system managers begin to budget for feet-to-the-fire costs, i.e., when system managers begin to believe what they are telling the contractors. In this same day-to-day continuum, feet-to-the-fire numbers have a way of turning into best estimates. When this occurs the threshold is crossed from contract pricing and negotiating dogma, of which feet-to-the-fire is a basic tenent, into program management practice wherein the best estimate of ultimate cost is expected[18/] regardless of whether the estimate coincides with contract target or ceiling amounts. When feet-to-the-fire costs, i.e., contract negotiating costs, are held to be best estimates they assume the mantle of Must Cost.[19/]

Yet another aspect of Must Cost relates to a contracting officer's position when negotiating with a potential weapon system supplier. The contracting officer in concert with the military command structure establishes his "negotiating position." This negotiating position takes into account not only the explicit proposal of the contractor, and the possible recommendation of a Should Cost study team but the implicit demands to hold costs at levels resulting from the Must Cost philosophy. There are no incentives for contracting officers to seek anything but the lowest cost in negotiated procurements. Thus, that part of the weapons acquisition institution closest to the bargaining table may look upon Will Cost estimates in horror. It is not unlikely

18/ See Secretary of Defense Laird's Memo for Secretaries of the Military Services, Subj: "Standard Weapon System Costs" dated May 6, 1969 (U).

19/ Former Assistant Secretary of the Army (I&L), J. R. Fox, alluded to this distinction in his Memorandum for the Secretary of the General Staff, Subj: AR 11-18, Cost Analysis Program, dated 4 May 1970, when he distinguished between the functions of evaluating price proposals by employing procurement dogma and the function of applying objective cost analysis.

that people closest to contracting activities will charge with great emotion and feeling of injustice that those who present Will Cost estimates, estimates in all likelihood higher than Must Cost estimates, are compromising their negotiating position. There may even be statements to the effect that those who present Will Cost estimates cause costs to rise.

Given the downward bias inherent in the weapons acquisition process, and assuming that a contractor has useful knowledge of a Will Cost estimate and further acts to adjust his proposal upwards, i.e., a worst case assumption, has the process experienced anything but an earlier, rather than later, release of cost pressure? In other words, given today's Must Cost environment,costs are going to rise, the presence or lack thereof of a Will Cost estimate notwithstanding.

The above worst case assumption tends, however, to be theoretical for several reasons. The most important reason, given a new procurement, is that the contractor because of competative pressures is as constrained to play the Must Cost game as is the Government procuring activity. Increasing his proposal cost as a result of acting on any Will Cost estimate could cause him to be non-competitive, a rather strong disincentive.

Given a second or subsequent buy under an existing major procurement where the contractor may feel he has the program "locked," the being non-competitive argument has less appeal. Given a) a Will Cost estimate that is higher, b) the contractor's useful knowledge of the Will Cost

estimate and c) the contractor's desire to raise his costs, we must question whether the trigger mechanism for the increased estimate is the Will Cost estimate or the underlying pressures created by downward bias. And, other than how this question may impact a Should Cost, Will Cost or Must Cost proponent's credibility, it would appear to make little difference. The pressures are there. Contracting procedures under Cost Plus contracts have not been developed which will preclude cost growth. The Government's options tend to polarize as either pay the bills or stop the program. Until such time as the acquisition process purges itself of downward bias, it is not a case of <u>whether</u> these pressures will be released but rather <u>when</u>.

Will Cost cost estimating techniques rely heavily on past experience. Because of this trait a school of thought has evolved which holds that Will Cost simply perpetuates the alleged defense industry inefficiencies by implicitly maintaining that historical costs represent optimal value. It is those who argue that the Government has been paying too much for its weapon systems for too long that argue Will Cost estimates are of little value. The counter argument is that hard resource allocation decisions must be based on the realities of what the Government will have to pay, not on what it would like to pay--not on what the Government, as one party in a two-party contract, believes it should pay.

However, applying the Will Cost philosophy in a meaningful way in a Must Cost environment is most difficult. The lack of a substantial, appropriately normalized data base causes analysts to make assumptions and

adjustments to available data that tend to be subjective. Thus, Must Cost proponents may well ask of WILL COST proponents: "Where is your professionalism, where is the objectivity?"

While applying independent parametric cost analysis techniques is most difficult, the process does offer a ray of hope in an otherwise dark outlook for improving weapon system cost estimates. The discipline involved and the techniques employed are not dissimilar to those of the "whiz-kid" era of former Defense Secretary McNamara. And, on occasion it is the now negative image of whiz kid wizardry that creates acceptance problems for these more rigorous evaluation methods.

In any event, some of the techniques are difficult to explain except in a language foreign to acquisition management. For example, describing time phasing of cost streams through the use of Beta distribution functions tends to subtract from the credibility of the estimate irrespective of the merit of Beta functions. Thus, feeling uncomfortable with the techniques and boxed in a competitive environment, acquisition managements will generally opt for the institutionalized cost--the Must Cost. Thus, given current incentive systems, the winner of the battle of cost estimating philosophies is MUST COST.

Living with a Must Cost number is not unlike living on the side of a volcano. One may live in peace and tranquility for years without getting burned.

V ROOT CAUSE OF COST GROWTH

The following has been observed:

* Defense markets have been declining and the product-mix within the markets has been shifting.

* The decline and shift in markets causes intense competition within industry.

* Competition for limited resources within Government causes downward pressure on estimated costs.

* Competition pre-contract award drives costs down.

* The buyer chooses the form of contract and specifies the ground rules under which buyer and seller will conduct their activities.

* The cost-plus contract, a necessary instrument of high technology procurement, is not designed to fix prices at point of contract award.

* Costs rise in the post-award period.

Given this chain of events, it is possible to establish the incentive systems at work. The military services, required to conduct their affairs with fewer dollars, have the incentive to stretch these dollars rather than to eliminate programs. There are incentives for the military services to

* State what a program Must Cost rather than what it Will Cost.

* Determine that a program Should Cost less than or equal to what it Must Cost.

* Allow requirements to become uncoupled from costs as changed requirements tend to cost more.

* Argue against use of costing methods at variance with Must Cost procedures.

Because there is one buyer and many sellers, each defense company has two broad incentives to minimize costs. One incentive is to help the buyer "look good" in terms of how much capability he can get for his money and the other incentive is to have, among competing designs for a given program, the lowest cost design. The first could be called an absolute incentive, the latter, a relative incentive. The first incentive is probably unique to one-buyer markets. The incentives for industry and the military are quite similar, generally reinforcing each other and may be synergistic.

Because of diminishing and shifting markets most defense contractors have the incentive to be docile and overly agreeable when besieged with demands for an almost infinite number of technical and managerial reports and information systems--for contract clauses that are not always consistent with good business practice--for a proliferation of contractor activities which the contractor will say are not necessary but, "if you insist." While seemingly contradictory, in the defense business, companies that are docile are competitive.

The thought is captured in the following passage:

> "...it is important to remember that in the final analysis defense contractors, whatever their motivations, are the products of their environment; those who do not accept its mores or fail to embrace its management fads, do not survive to ponder its inadequacies." 20/

What has been suggested in this paper is that competition is the big problem while requirements becoming uncoupled from costs is a related problem and one which masks pre-award competition's impact on post-award costs. Factors mentioned as contributing to the uncoupling process include:

* Budgeting and technical functions not interrelating.
* Administrators not relating costs to requirements.
* Annual budgeting process making a patchwork quilt of requirements and costs.
* Too many people in on the act.
* Ground rules making sound cost estimates difficult.

These conditions present opportunities, if not vehicles, for perpetuating the downward bias in costs. This is a bias in which, as a result of the environment, both buyer and seller have vested interests.

20/ Defense Acquisition Study, Op. Cit., p 10.

Numerous specific actions could be taken to solve each of the lesser problems; however, such problems would probably simply reappear as some new manifestation of the environmental problem. Attempting to correct pieces of the problem is not the answer. The environment must be changed.

The defense industry is not healthy. The demise of bargaining power between buyer and seller carries as profound implications for the buyer as for the seller. Monopoly, that market condition wherein the seller controls supply and seeks to maximize profits, is characteristically viewed with alarm and countered with appropriate legislation. Monopsony, that market condition wherein the buyer controls demand and seeks to minimize costs, is simply and unfortunately an economic curiosity given little attention in either governmental or academic circles. Monopoly, particularly in its more virulent forms, is considered to be not in the public interest. Should not monopsony be viewed with similar concern?

Must Cost is the philosophy of a monopsonist. Should Cost is one of his tools. Were it not for an imperfect, albeit necessary, contracting instrument, the Cost-Plus type of contract, the cost estimate reductions garnered through monopsonistic practices pre-contract award would stand post-award. In that these reductions are believed quite substantial generally proportional to cost growth, a forcing of defense companies to

live with their early estimates, estimates that were products of a monopsonistic environment, might lead to numerous bankruptcies[21]. In such an event, the probability is believed high that the defense industry, at least as we know it today, would cease to exist within a decade. Would that be in the public interest?

The root cause of cost growth on major weapon systems is monopsony. Cost Growth is the backlash of monopsonistic practices.

When a matter of great importance is being handled inappropriately, we tend to think in terms of identifying and admonishing the responsible party. Implicit in this procedure is that the party is one person or at most a few people. But what is our procedure if the party is an institution where large numbers of individuals conduct themselves in an individually commendable manner but whose collective actions create problems? To illustrate this difficult point, I am reminded of a meeting of senior Government officials gathered to review the scientific aspects of a new weapon system, the contractor for which had been selected but not announced. In his opening remarks, one official cautioned the rather large audience that while a few knew of the contract winner, the company should not be mentioned by name as official Government release was still pending. The official concluded in good humor: "It's not that I don't trust you each individually, I do--but I worry about you collectively."

[21] While many causes have been attributable to the Lockheed debacle, the reader may wish to reexamine that situation in the light of the theory presented here.

Monopsony is a collective phenomena. It is an aggregate condition producing an aggregate result. No one is to blame; everyone is to blame.

It would appear that any long-term general solution has two facets. First, we need to establish balanced bargaining positions between buyer and seller--to establish an environment wherein either party can walk away from the negotiating table with a, "Thanks, but no thanks." Second, we need to reduce or eliminate government in-house competition for resources. This is not to say eliminate the very necessary competition between weapon systems, e.g., the kind of competition implicit in cost benefit analysis but rather to eliminate the competition between in-house organizations for resources.

Establishing equal bargaining positions and suggesting that contractors walk away from the negotiating table may appear, especially to procurement people, as a "sell-out" to industry. Less readers jump too rapidly to that conclusion, consider the fact that one way to establish balanced bargaining postitions is to bring supply and demand into balance by reducing competition for defense work. This can be accomplished by enforcing the contracts we, the DOD, award. This might very well eliminate the Lockheeds and Grummans as serious contenders for future work and would in any event cause others to think twice about their cost estimates--hardly a sell-out to industry. But, perpetuating a monopsonistic environment while at the same time enforcing the contracts of that environment is nothing less than Machiavellianism. The means by which we would establish equal bargaining positions is as important as the end product.

The point is, weapons acquisition is a most complex topic. If we have learned anything from total package procurement, concurrency and the myriad other approaches to the acquisition process it is that we know very little. I have studiously avoided suggesting detailed solutions. The destination is unimportant at the moment; the question is whether we are even headed in the right direction.

Establishing balanced bargaining positions and eliminating in-house competition for resources are directions requiring whole new patterns of thought including considerations of morality. And, it is not clear that changes required to improve the weapons acquisition process will have political appeal. Inertia has its own inexorable law governing change. Nevertheless, the weapons acquisition process is confronted with an internal struggle of immense proportions--a struggle over the philosophies embodied in Should Cost, Will Cost and Must Cost. It is a propitious time to reflect on the real cause of cost growth.