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AN ANALYSIS OF THE IMPACT OF MULTI-YEAR PROCUREMENT ON WEAPON SYSTEM ACQUISITION

Jonathan L. Brearey, Major, USAF

LSSR 62-81

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ISSR 62-81	2. GOVT ACCESSION NO. AD-A107	3. RECIPIENT'S CATALOG NUMBER 708
4. TITLE (and Subtitle) AN ANALYSIS OF THE IMPACT OF MULTI-YEAR PROCUREMENT ON WEAPON SYSTEM ACQUISITION		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Jonathan L. Brearey, Major, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS School of Systems and Logistics Air Force Institute of Technology, WPAFB OH		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Department of Communication and Humanities AFIT/LSH, WPAFB OH 45433		12. REPORT DATE September 1981 13. NUMBER OF PAGES 138
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

2 OCT 1981

Air Force Institute of Technology (ATC)
Wright-Patterson AFB, OH 45433

18. SUPPLEMENTARY NOTES

APPROVED FOR PUBLIC RELEASE AFR 190-17.

Fredric C. Lynch
FREDRIC C. LYNCH, Major, USAF
Director of Public Affairs

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MULTI-YEAR PROCUREMENT
MULTI-YEAR CONTRACTING
MULTI-YEAR FUNDING
ANNUAL PROCUREMENT
PROCUREMENT STRATEGIES

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Thesis Chairman: Ronald H. Rasch, Major, USAF

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Increasing concern over the rising costs of weapon systems and the deteriorating efficiency of the Defense industrial base has stimulated initiatives toward reducing costs and improving the capability of the U. S. Defense industry to react in times of crisis. Growing evidence indicates that these cost and efficiency problems have been caused, in part, by instabilities in Government procurement programs. Specific Government practices which have contributed to these problems are unpredictable annual funding, quantity changes, and program stretchout. One approach toward reducing costs and restoring the Defense industry's health is expanded use of multi-year procurement(MYP). This research reviews many of the recent initiatives toward expanded use of MYP and analyzes the theoretical impact that multi-year commitments may have on weapon system acquisition. The author presents a comprehensive discussion of the advantages and disadvantages of MYP and produces a set of criteria which can be used to select procurement programs for multi-year contracts. These criteria are organized into a decision model which can be used to analyze a program and determine its appropriateness for MYP.

ALSSR 62-81

AN ANALYSIS OF THE IMPACT OF MULTI-YEAR PROCUREMENT ON WEAPON SYSTEM ACQUISITION

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Systems Management

By

Jonathan L. Brearey BS
Major, USAF

September 1981

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This thesis, written by

Major Jonathan L. Brearey

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS MANAGEMENT

DATE: 30 September 1981

Ronald H. Rauch
COMMITTEE CHAIRMAN

James N. Berfield
READER

ACKNOWLEDGEMENTS

This thesis could not have been accomplished without the assistance and material provided by many individuals who deserve recognition.

I would like to thank LtCol Kary LaFors, Chief, Contract Administration Division, DCS/Contracting and Manufacturing, Air Force Systems Command, and Mr. John S. W. Fargher, Jr. formerly of the DOD Defense Systems Management College, for the much needed information they supplied. Their help has been invaluable.

I would also like to thank the numerous individuals in the Aeronautical Systems Division at Wright-Patterson AFB, Ohio, who shared their knowledge, experience, and/or data.

My thesis chairman and advisor, Major Ronald H. Rasch deserves special thanks for his patience, guidance, and assistance during the many readings and discussions concerning this paper. Also, many thanks are extended to LtCol James N. Bexfield for his constructive comments as reader of this paper.

My wife, Nancy, who typed this paper countless times and who shared the burden deserves my sincere thanks for her patience and support.

Finally, I would like to thank all the professionals of the Air Force Institute of Technology for making this learning experience truly rewarding.

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CHAPTER I

INTRODUCTION

Acquisition Program Cost Growth

Escalating costs associated with modern weapon systems acquisition programs are of significant interest to system program managers as well as associated funding agencies (72:9-15). The investments necessary to acquire and operate major weapon systems have a strong impact on the allocation of national resources. The 1981 federal budget had planned appropriations of $57 billion for defense related research and development (R&D) and procurement (70:422-423). These appropriations represent 8.2% of the total federal budget. A one percent increase in appropriations for R&D and procurement due to increased costs would be a significant sum of money ($570,000,000).

The terms "cost growth" and "cost overrun", have been used indiscriminately in the past, resulting in some confusion (79:14-20). Cost growth originally referred to cost increases that were due to influences beyond the control of weapon system acquisition program managers. In contrast, cost overrun was associated with increases which were within the control of the program manager (79:14-20). Cost escalation or cost growth will be used in this research as general terms to

identify the difference (increase) between initial development contract target cost and the actual final cost for the contract. (Note: Since full contract settlement may not occur for several years after program completion, the final price is actually an estimated final price).

Cost escalation causes are varied. Some are more easily understood than others, but they all contribute to increasing concern over their control (38:11-16). "Cost growth of weapon systems is a highly complex and multi-faceted problem involving economics, military judgement and politics [84:4]."

Increased complexity and expanded technology of today's defense systems accounts for a large portion of this cost growth (14:4; 85:26). Additionally, higher than estimated inflation will cause an increase in total acquisition expenditures and has an aggravation effect on the additional expenses associated with program length (55:14-25; 65:40). These causes are a product of the modern industrial arena in that they encompass ever increasing technology, economic competition for resources and funding and development uncertainty (42:155-157). Past studies and symposiums have identified these factors as significant contributors to weapon system cost growth (6; 11; 21; 35; 42; 43; 55; 62; 65). However, the problem of cost growth continues (41:91). The estimated costs for defense projects, including additions, increased $111.7 billion dollars in fiscal year 1980 (10:1).

There are two basic categories of cost growth: paper growth and real growth (84:5). Paper growth concerns the

costs which were experienced as compared to the estimated costs. These estimates are the planning estimates, the development estimates, and the production or current estimates. Initial appropriations are usually requested of Congress based on the planning estimate. This estimate is a rough guess based on current knowledge of cost trends and strives to project the full costs of a weapons systems 5-10 years before actual production. The development estimate occurs closer to the production time frame but still lacks much needed knowledge for accurate cost estimates. The production estimate is a more refined cost projection because "technological and production problems are identified, decisions on operating characteristics and cost trade-offs are being made, sub-systems are chosen, . . . [84:6]."

In many cases, these early estimates fall short of the actual costs. The reasons for low estimates are varied, complex, and controversial. They include the downward pressure on estimates within the government due to limited resources, precontract award competition, and changed technical capability requirements (6:41-61; 61:57).

In contrast to paper growth, the real growth phenomenon derives its root causes from systems technology. Advanced technology has become the permeating philosophy of weapons acquisition planners and developers (84:8). This philosophy has evolved in order to overcome the numerical advantages in manpower and weapons held by our adversaries (35:44). This drive for greater capability has led to the need for more

complex electronics/avionics, fire control systems, etc. These new technological horizons are in many cases undeveloped and possibly even futuristic. They have a degree of uncertainty associated with them which makes cost estimates extremely speculative (62:166). To aggravate this cost uncertainty, engineering changes may be required during any of the research, development, testing, and evaluation (RDT&E) stages. They may also be required during production. These design changes can and often do increase acquisition costs (85:8).

Statement of the Problem

Funding Methods

There are three main categories of appropriations: no-year, multiple-year, and annual (11:14). No-year appropriations remain available for obligation until expended. Multiple-year appropriations are made available for a specific time period such as 5 years; however, annual appropriations are only available for obligation for the current fiscal year unless otherwise designated by law. Regardless of the category of appropriations, funds for acquisition programs are supplied on a year-by-year basis and result in annual buys even for programs that stretch over many years (90:1576). This practice is commonly termed annual funding.

Funding Uncertainties

Annual funding is the primary funding method for the acquisition process. This funding method introduces many cost

problems into the acquisition program (83:V-12,V-13). Cost estimates must be based on limited quantity purchases of equipment, material, labor, and other factory requirements. When the duration and size of the contract are uncertain due to limited funding commitments (annual funding), the civilian contractor is hesitant to invest substantial sums of money into his industrial base (11:28-31; 83:V-16,V-17). This uncertainty over funding has precluded many contractors from taking part in the defense systems contracting business. Additionally, since program cancellation or curtailment could occur without a multi-year commitment by the government, efficient quantity purchases of all aspects of production are risky and are frequently forgone. General Slay, former Commander, Air Force Systems Command (AFSC), cites the following example:

> We receive an annual authorization bill from the Congress which indicates, for example, the maximum number of F-16s we will be allowed to procure this year, say 180, or 15 per month. Later, we receive an appropriations bill which may fund the number of aircraft previously authorized or may fund a lesser number, say 120, or 10 per month. Once we have all other necessary approvals, we ask the prime contractor for his proposal for these 120 aircraft, review his projected costs, negotiate a price, and award a contract. Then, the contractor will order most of the materials and components for these 120 and eventually start manufacturing [83:VII-29].

In addition to funding uncertainty not associated with cancellation or curtailment, there are many times when programs are "slipped" or stretched out in order to spread limited funds around to all programs (83:V-13,V-15). When this occurs, the contractor must reduce production and consequently allocate

period overhead costs to the reduced production rate.

The General Accounting Office (GAO) presents the following discussion concerning this problem:

> The weapons also may be produced at a limited rate because sufficient funds are not available in the DOD budget to produce a greater number in a given year. Whatever the reason for limiting production of an item to less than the optimum rate, the effect of this action is a loss of productivity and an increase in the cost of major weapons.
>
> Our findings, in connection with an earlier review of F-14A aircraft procurement, show the magnitude of the effect of production rates on cost and efficiency and the complexity of related matters which must also be considered in setting the rates. We learned that a reduction of 66 in the number of F-14A aircraft to be procured and an increase in the time over which they would be produced had increased estimated program cost by $2.3 billion--about 38 percent. In January 1969, the Navy planned to procure 469 F-14 aircraft (6 development and 463 production) at an estimated total program cost of $6.2 billion or $13.2 million per aircraft. The production aircraft were initially to be produced over a 6-year period from 1971 through 1976. The revised plan stretched the reduced total of 403 aircraft (12 development and 391 production) through fiscal year 1981 at an estimated total program cost of $8.5 billion, or $21.1 million per aircraft. We estimated that the Navy could have saved about $640 million if the production rate for the aircraft remaining to be produced at the time of our review was increased to the contractor's optimum rate of eight per month. Furthermore, the contractor for the F-14A's weapon control system stated it could produce in 1 year all of the remaining control systems then planned to be produced over a 4-year period and estimated the savings at about 38 percent--$109 million.
>
> The following chart was provided by a contractor from data derived from its own cost and production records of an actual program:

Impact of Quantity/Rate on Unit Cost

	QTY	Unit Flyaway Cost	MFG Portion Of UFC	Non-MFG Portion Of UFC
Planned	200	$10M	$ 8M	$2M
Reduced to	50	[illegible]M	10M	8M
$ Increase		$ 8M	$ 2M	$6M
% Increase		80%	25%	300%

The cost penalties resulting from stretched production and the restraint of production rates below the optimum levels of production efficiency are clear and substantial in these examples. However, on the other hand, the following considerations related to the F-14A are fairly representative of the types of very real counterforce factors complicating the choices and decisions regarding the term and rate of production.

--The industrial base for the system could become inactive and adversely affect a restart of production if needed.

--Going from full production to no production within a short time frame could have an adverse effect on both the stability of the contractor's organization and the local economy.

--Increased costs could result from having to incorporate possible later design changes on a larger number of completed units.

--Storage and caretaking costs would be incurred in instances in which the component manufacturers have the capability to produce their items in excess of the end item production schedule. Some weapon control systems components, for example, would require regular servicing at 6-month intervals to maintain their shelf-life during a wait for installation in airframes [11:11-13].

Another effect of annual funding is reduced commitment to a specific design, technology, and quantity (82:Atch-1; 89:88). Although this might be an advantage with respect to

technology changes and requirements flexibility, it is a primary cause of cost growth (85:8; 35:40).

Because the deficiencies of annual funding have been recognized, increased interest in multi-year procurement (MYP) has arisen. Jerome Stolarow of the GAO has stated:

> Where appropriate, we believe that there is potential to apply the multi-year funding concept to encourage greater contractor investment and to enable procuring agencies to plan more economic rates of production[84:15].

Multi-year procurement has the advantages of quantity purchases at now-year prices. It also allows for realistic planning by both the systems acquisition agency and the contracting company (82:Atch-II).

Walton H. Sheley Jr., of the GAO advocates multi-year agreements because contractors can spread start-up and pre-production costs over a longer period of time with more opportunity for increased efficiency and productivity. He notes: "These contractor benefits should be transformed into decreased unit prices to the government [89:88]." Additionally, MYP requires that commitments be made by Congress in the form of long term contracts. This will reduce uncertainty and encourage industry to modernize and apply other capital improvements to their industrial base. The problems involve law changes with regard to cancellation ceilings and the inclusion of recurring costs in the cancellation charge (8:27-28). Some regulatory changes are also required (90:1404). Some aspects of the concept are relatively new and untried, but MYP appears to have significant

potential for cost savings.

Since the multi-year concept is relatively new and untried for weapons system acquisition, and since the total effects of multi-year procurement are complex, possibly involving huge appropriations and national priorities, a complete analysis of all effects seems necessary. General guidelines derived from this comprehensive analysis should help decision makers understand and correctly apply the multi-year concept.

Research Objective

The objective of this research is to compare the annual and multi-year concepts with respect to projected program development and to provide useful guidelines for deciding whether annual or multi-year procurement is appropriate. For this research, "appropriate" will be with respect to total cost and possible causes of cost growth. (See Tables 1 and 2 which present two comprehensive lists of cost escalation causes).

Program development is multifaceted as can be seen by the attached Figures 1 through 6. Figure 1 provides a schematic of the DOD Acquisition Process and Figure 2 depicts the development plan options and the impact of uncertainty (risk) on the option/decision. Figure 3 depicts the relationship of the R&D categories, engineering design phases and the systems engineering decision process. Figures 4 and 5 illustrate the relationships between technical uncertainty/risk

TABLE I

Selected Causes of Contract Cost Growth

Preactivation*	Activation*
1. Cost Estimation a. Cursory cost analysis b. Lack of competition c. Projection & estimating process d. Contractor underpricing	1. Economic Factors a. Inflation b. Order reduction
2. Research & Development Specifications a. Concurrency of research and development with production b. Extraneous design requirements c. Faulty technical planning	2. Detailed Management Practices a. Lack of cost control b. Inadequate control of sub-contracts c. Excessive reporting requirements
3. External Environment Factors a. Budgetary constraints b. Uncertainty estimation	3. General Management Practices a. Changes in defense procurement policy b. Late delivery of government furnished property c. Program stretch-outs
4. Internal Environment Factors a. Communication problems b. Risk analysis c. The negotiation process	4. Technological Considerations a. Technological obsolescence b. Engineering changes c. Program reduction

*Preactivation--The time immediately prior to the award of the development program contract.

*Activation--The time period from development program contract award to contract close-out.

[43:11]

TABLE 2

Causes of Cost Growth*

1. Quantity--changes including scope.
2. Engineering--changes altering a system's established physical or functional characteristics.
3. Support--changes involving spare parts, ancillary equipment, warranty provisions, and Government-furnished property or equipment.
4. Schedule--changes in delivery schedule, completion date, or some intermediate milestone of development, production, or construction.
5. Economic--changes that are influenced by one or more factors in the economy, such as inflation.
6. Estimating--correction or other changes occuring since the initial or other baseline estimates for program or project costs.
7. Sundry--changes other than the above categories, such as environmental costs and relocation assistance for water and highway projects.

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* GAO Cost Growth Categories

[10:2-3]

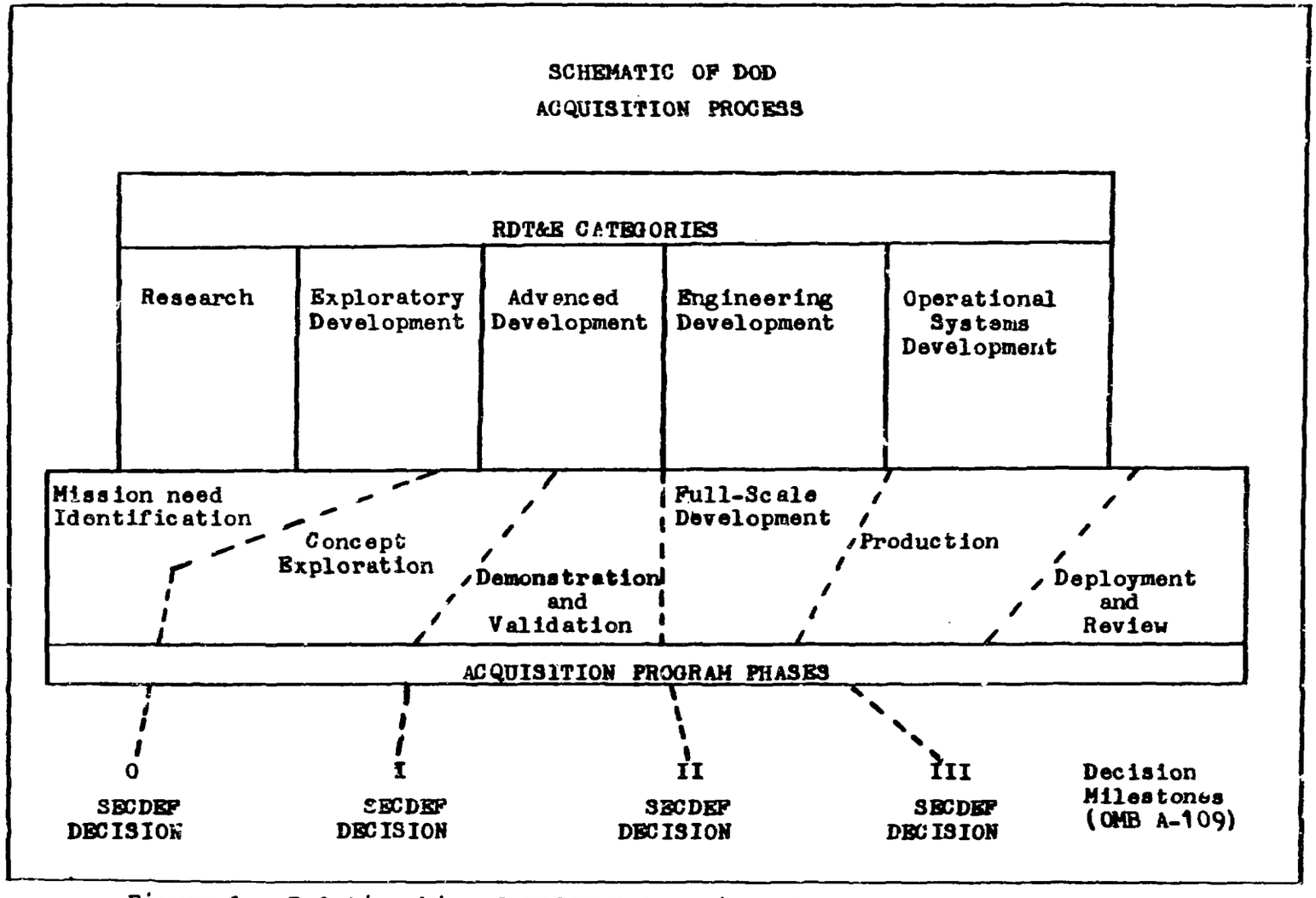

Figure 1: Relationship of RDT&E Categories, Program Phases, and Acquisition Decision Points (24; 25).

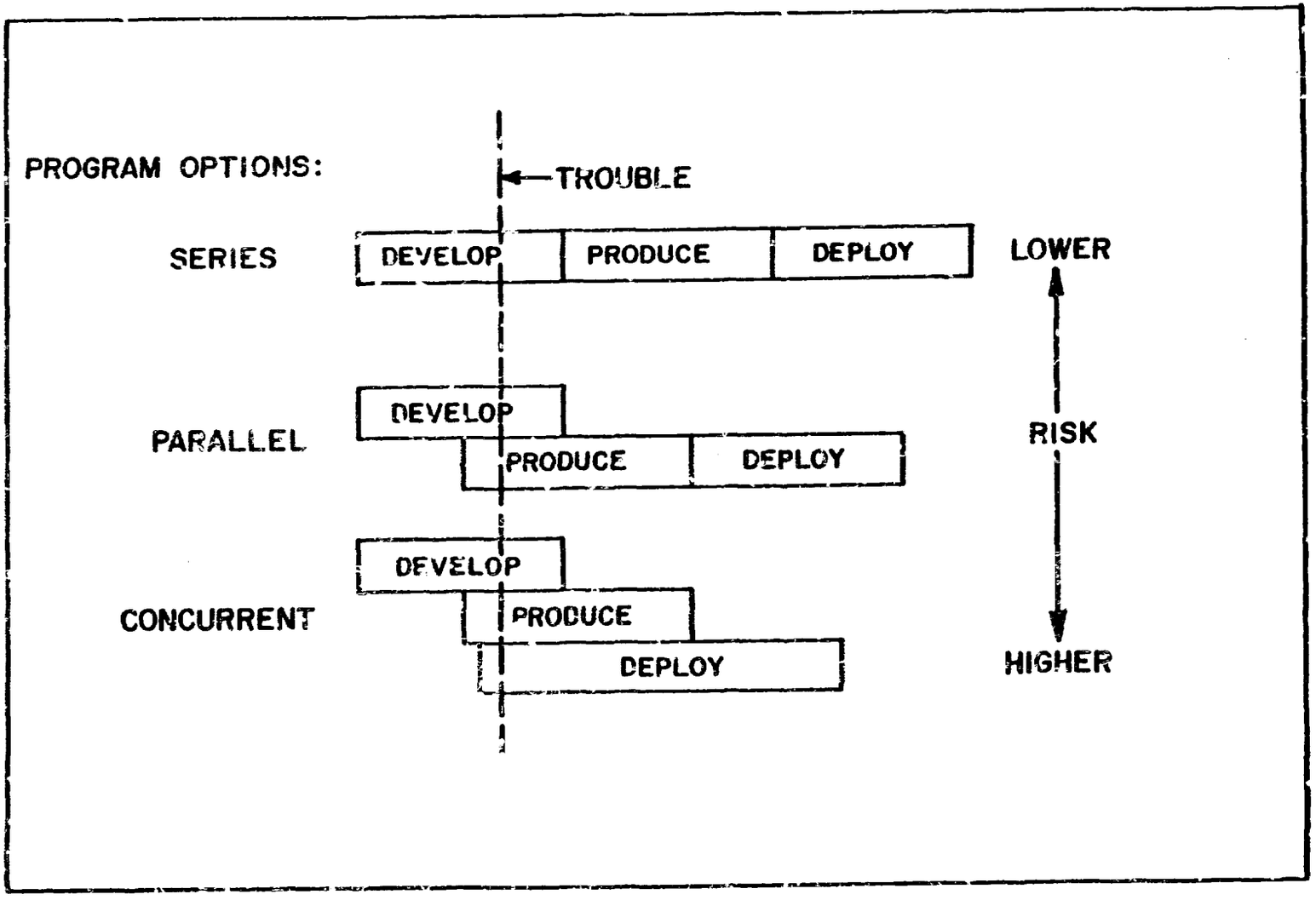

Figure 2: Impact of Uncertainty/Risk on Program Options (42:83).

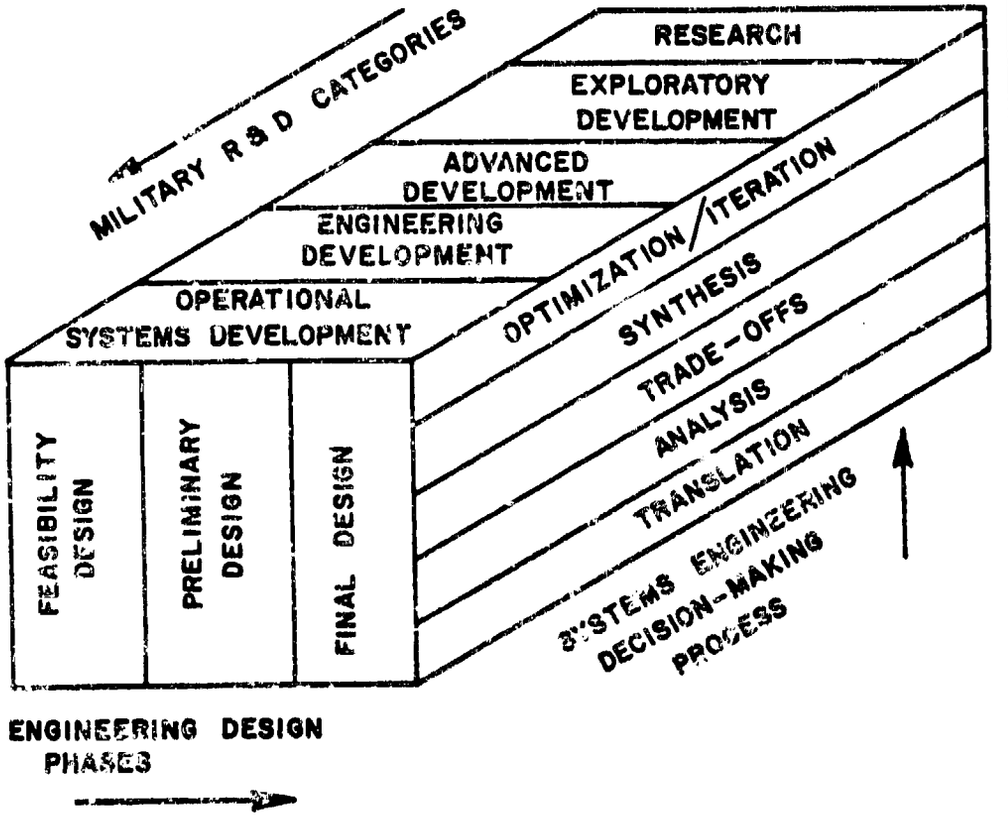

Figure 3: Military R&D Categories, Engineering Design Phases & Systems Engineering Relationships (42:74).

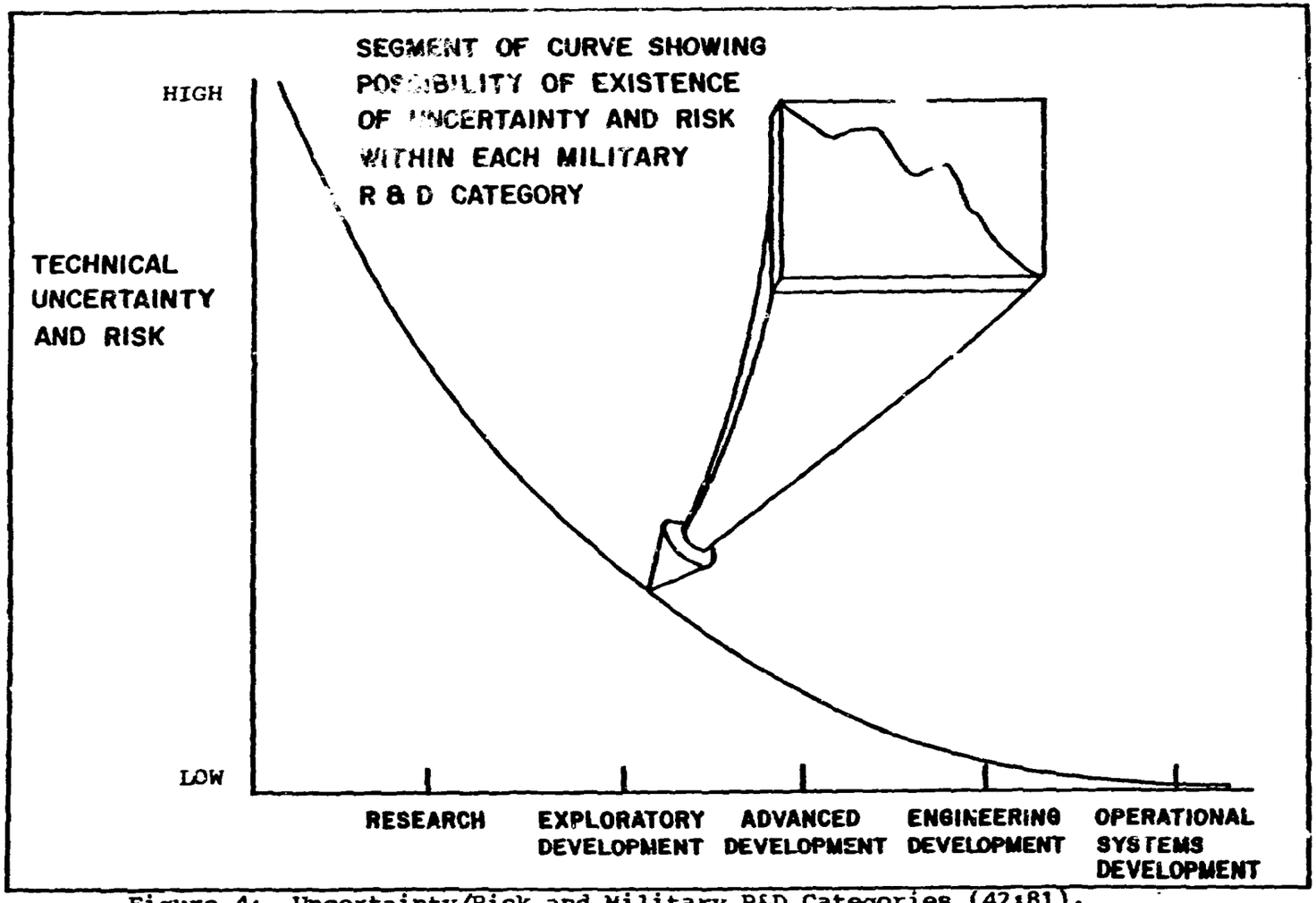

Figure 4: Uncertainty/Risk and Military R&D Categories (42:81).

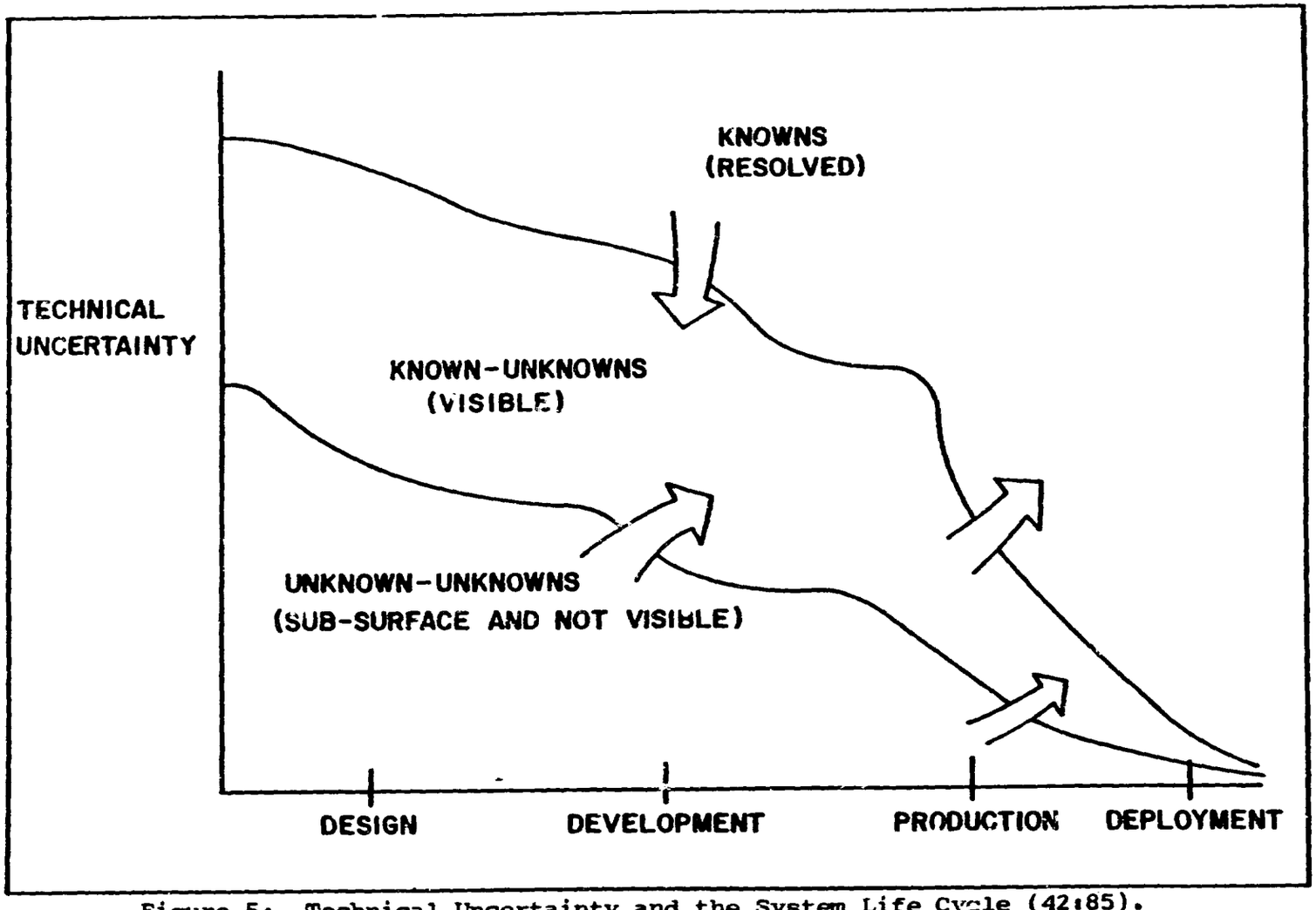

Figure 5: Technical Uncertainty and the System Life Cycle (42:85).

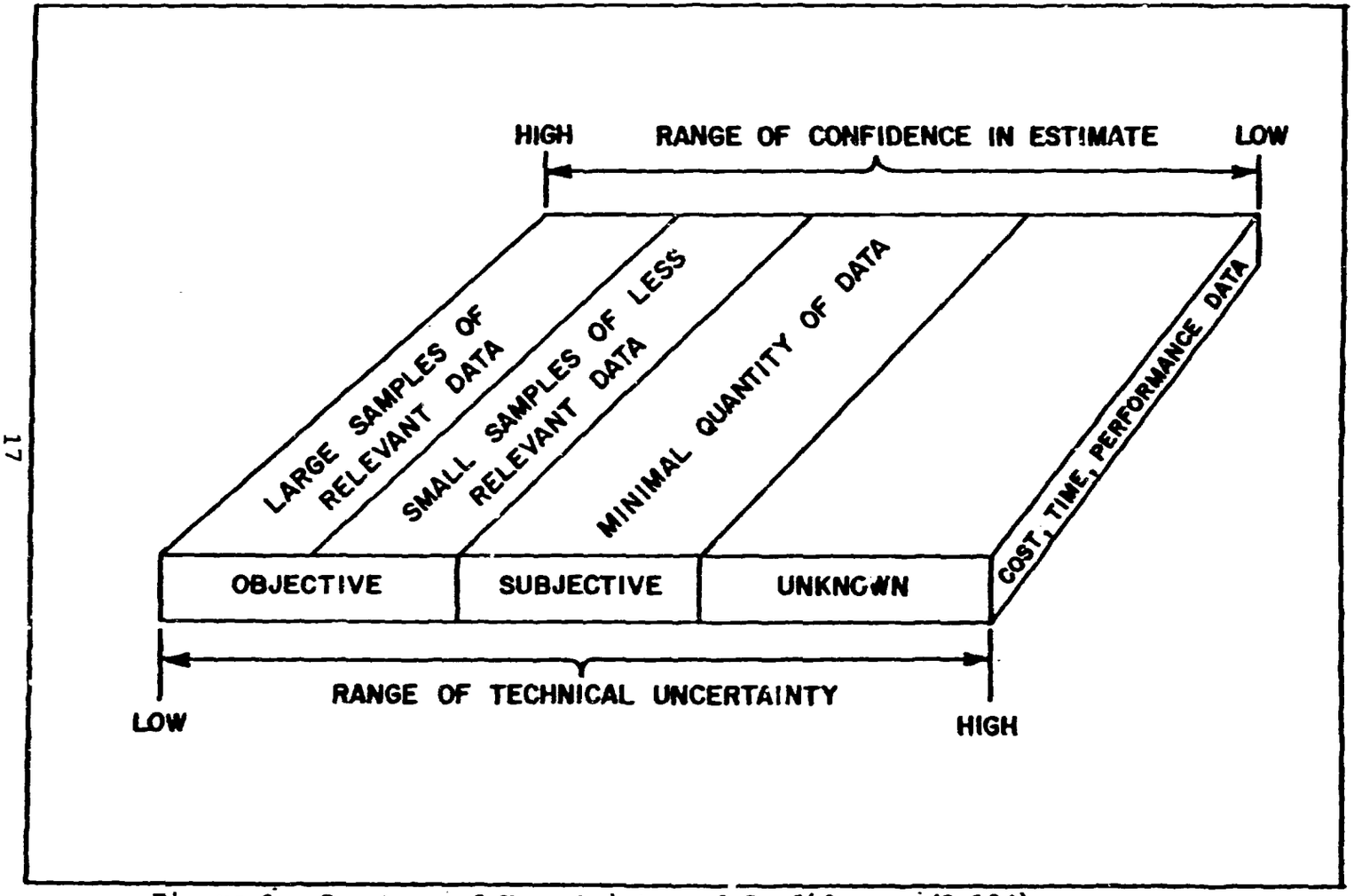

Figure 6: Spectrum of Uncertainty and Confidence (42:104).

and the acquisition phases. Figure 6 relates this uncertainty/risk to cost estimates. These cost estimates are in many cases the information on which decisions concerning the program direction. size, length, sophistication (technology), and funding are based. This, consequently, effects the total acquisition process.

The proposed F-16 contract serves as an example. The F-16 program has been in existance for several years and has produced nearly 450 airplanes. The program is in the production and deployment phases with uncertainty and risk rather low. (See Figure 5). Currently, the contract is the annual type where Congress authorizes the purchase of so many aircraft for the upcoming fiscal year and appropriates funds for that contract. There is no commitment for purchases beyond the next fiscal year although future purchases are expected. The contractor is not inclined to invest in more than the amount appropriated, and the quantity purchase break of raw materials by the prime contractor (General Dynamics) is forgone (83:VII-30). The F-16 System Program Office (SPO) is proposing an expanded[1] multi-year contract for Congressional approval so that the Air Force can realize substantial savings due to program stability (82).

This research will attempt to develop a decision model which incorporates the RDT&E and production stages and the

---

[1]By law, the standard multi-year cancellation ceiling is $5 million (22:1-322.1(a)). This is far below that needed for the F-16 program (82).

associated risks (See Figure 5). (Note: Each stage for each program will have some probability-of-risk which usually decreases as the program nears production). The objective of the model is to aid the program decision maker in deciding upon a procurement method--annual or multi-year. Within each stage of the acquisition process, program priorities and technical uncertainty influence program direction and the ultimate funding decision. The identification of the numerous factors involved in arriving at this decision will be the objective of this research.

Scope

The decision model will be based on logical conclusions and what appears to be the consensus of opinion from recognized experts. It is intended to provide a heuristic approach to applying appropriate criteria to the procurement method decision. Although there is a definite need for numerical analysis of the benefits and risks of multi-year procurement, the time requirements and the limited availability of data place such an endeavor beyond the scope of this research. This research, however, should provide a thorough topical review, including a theoretical analysis of cost implications, which can provide a firm springboard for further research into the subject.

Methodology

A firm understanding of the various cost elements

involved in procurement is essential to evaluate the cost impacts of alternate program decisions. The basic method of part of this research will be the development of the fixed and variable cost elements and their relationship to direct and indirect material and labor. Other cost elements such as general and administrative costs will be identified where applicable. A presentation of the interdependence of cost, schedule, and performance will be included so that the impact of particular program decisions can be assessed. Also, the impact of uncertainty on the acquisition process will be developed so that the complexity and appropriateness of funding decisions can be applied to the decision model.

The specifics of annual and multi-year concepts will be thoroughly reviewed including legislative implications. Since a prime consideration of this thesis is cost growth and the appropriateness of each funding method, the impact of authorization and appropriations process for each will be reviewed. Cost growth possibilities identified with each funding method will be examined and brought into the program model.

Finally, a sample application of the model will be presented using data from the F-16 and other similar programs.

CHAPTER II

PROCUREMENT FUNDING METHODS

Background

The process of funding commercial transactions to meet the needs of national defense dates back to original United States constitutional provisions (19:20-1). In clause 7, section 9, article 1, the constitution states that no money shall be taken from the treasury unless appropriated by law. Also, clause 12, section 8, article 1 provides for Congressional funding ". . . to raise and support Armies, but no appropriation of money to that use shall be for a longer term than two years [20:4]." There is little doubt that the requirements of the Department of Defense have changed dramatically since the early days of this nations formation. With the exception of ships most defense needs could be filled in a single year. Since these early days the time required to identify, plan and manufacture weapons for the national defense has increased significantly. A Defense Science Board task force recently found that the time between mission need identification and Initial Operational Capability (IOC) of a major weapons system is now typically 17 years (94:328). As an example, the F-111 program began research and development in 1961 and completed procurement in 1975;

a period of 15 years. Other examples of current weapons systems are included in Table 3.

TABLE 3*

	F-111 R&D/Procurement	F-15 R&D/Procurement	Phoenix R&D/Procurement
1961	4.8/0		
1962	6.1/0		
1963	115.6/0		22/0
1964	321.1/0		64.3/0
1965	321.3/185.2		84.5/0
1966	264.0/481.4		68.6/0
1967	168.0/932.2	1.0/0	71.6/0
1968	229.1/861.9	1.0/0	32.6/30.9
1969	99.5/766.7	75.5/0	33.7/55.2
1970	128.2/805.6	175.1/0	17.5/0
1971	49.5/643.3	349.5/0	7.6/98.1
1972	8.8/452.5	422.0/0	3.6/103.6
1973	2.5/181.4	454.4/469.3	5/87.2
1974	0/159.7	258.0/868.4	4.1/81.8
1975	0/82.6	184.2/906.4	0/98
1976		35.0/1549.3	0/98.3
1977		51/1489.4	10.8/84
1978		25/1636.8	18.1/109.9
1979		10/1503.1	19.2/112.1
1980		5/1337.7	16.8/112.0
1981		5/3.9	2.5/36.6
1982			2.5/0

*Weapon System Funding in $Millions for Research and Development (R&D)/Procurement. Source: ASD cost library, Selected Acquisition Reports (1).

Because of continuing change and complexity in defense requirements, time and cost of acquisition have grown and

subsequently influenced the authorization and appropriations process. Indeed, in 1904, the Attorney General considered the two year restriction of appropriations to raise and support Armies and concluded that the word "support" does not extend to appropriations to arm and equip Armies. Additionally, in 1948, this interpretation was further upheld when the Attorney General advised the Secretary of the Air Force that an appropriation for procurement of aircraft was not subject to the two year limitation (20:4). Never-the-less, the Congress has sole authority for the authorization and appropriation of expenditures of public money. This is performed each fiscal year during the congressional budget process and results in fiscal legislation which prescribes the types of appropriations and their restrictions (71:24-28).

There are many types of appropriations (19:1-1):

1. One year appropriations--available for obligation only during a specified fiscal year.

2. Multiple-year appropriations--available for obligation for a specific period in excess of one year.

3. No-year appropriations--available for obligation until expended.

4. Definite appropriations--specific sums available for obligation.

5. Indefinite appropriations--sums determinable at some future date.

6. Permanent appropriations--automatically appropriated

each year due to existing legislation.

7. Unexpired appropriations--available for incurring obligations.

8. Expired appropriations--no longer available for disbursement toward existing obligations.

These types of appropriations may be and frequently are combined. Prior to FY 1971 the Air Force Aircraft (3010), Missile (3020), and Other Procurement (3080) appropriations were no-year appropriations and were available for obligation until expended (20:61). Since 1971, however, these appropriations have been designated multiple-year and are available for obligation for three years. Similarly, research, development, test and evaluation appropriations were changed from no-year to multiple-year appropriations and available for obligation for two years. The distinction between these types of appropriations is important, and, as will be discussed later, have further restrictions imposed upon them by regulation. Appropriations may be severely restricted with respect to obligation--the legal requirement for disbursement of funds. The obligation is valid if the (1) funds are available, (2) the requirement is specific, and (3) in the case of annual appropriations, ". . . the supplies or services contracted for must be intended to service a bona fide need of the current fiscal year [19:20-2]."

There exists some confusion over the exact meaning and required disposition of the funds appropriated by Congress

within the above mentioned appropriation categories. The following discussion of the most frequently used terms is intended to clarify their meanings. Several of them have been included in the Department of Defense's "Policy Memorandum on Multi-Year Procurement" (29:Encl-1).

Annual Funding

This is the current procedure for funding most programs. The authorizations and appropriations are limited to one fiscal year at a time. The yearly budgets prepared by the DOD reflect this policy by specifically requesting those funds which are intended for the upcoming fiscal year's programs (40:29). Annual funding should not be confused with one-year, single-year, or annual appropriations which restrict the executive branch from obligating the funds beyond the current fiscal year. Annual funds may be designated as either one-year, multiple-year, or no-year appropriations.

Full Funding

All funds required to cover the total estimated cost to deliver a given quantity of useable end items must be available at the time of contract award. This requirement has its basis in DOD Directive 7200.4 which states in part

> . . . the objective is to provide funds at the outset for the total estimated cost of a given item so that the Congress and the public can clearly see and have a complete knowledge of the full dimensions and cost when it is first presented for an appropriation. In practice, it means that each annual appropriation request must contain the funds estimated to be required to cover the total cost to be incurred in completing delivery of a

> given quantity of useable end items, such as aircraft, missiles, ships, vehicles, ammunition, and all other items of equipment. . . [23:2].

The policy applies only to DOD programs which are covered within the procurement title of the yearly appropriations act. It affects production contracts but not RDT&E contracts. An exception of the policy permits the procurement of long lead time components in advance of the year in which the associated end item is purchased. The full funding policy prohibits any DOD agency from procuring an entire program of which production may span several years by paying for it as costs are incurred. This policy was adopted at the persuasion of Congress and the Office of Management and Budget (OMB) to preclude instances where acquisition programs are started without sufficient funds available for completion, leaving subsequent Congresses and administrations the necessity of funding completion or terminating the program prior to completion (69;10; 90:437).

Incremental Funding

In contrast to full funding, incremental funding means that funds are not totally available at the time of contract award to complete the program. This type of funding is commonly used for RDT&E cost reimbursement programs because there is no restriction as in the case of procurement. Incremental funding has been called "spoon feeding" because it applies funds in increments to the contractor as costs are incurred and objectives are met (58:6). This type of funding should not be confused with progress payments which are primarily used

with the fixed price contract.

Multi-Year Funding

This type of funding is in contrast to annual funding. It is the practice by which Congress authorizes and appropriates funds for programs in excess of one year. This term should not be confused with multiple-year appropriations described earlier which specify the obligation time limits imposed on the executive branch. The importance of this term is that it refers to longer term funds appropriated by Congress for the purpose of funding program requirements for periods in excess of one year. Multi-year funding and multi-year contracting are not synonomous although they may accompany each other. The relationship of multi-year funding and multi-year contracting will be discussed in detail later in this chapter.

Termination Liability Funding

This funding method entails obligating sufficient contract funds to cover the contractor's actual costs plus termination charges should the contract be terminated prior to completion. The termination charges are based on predetermined criteria mutually agreed upon by the contractor and contracting agency. With this alternative to full funding, the government pays the initial costs to begin manufacturing of long lead components and subsequently full funds them when the end items are procured (91:39).

The above brief discussion of certain procurement terms indicates that there are various procurement funding options which might be employed in the acquisition process. The following is a discussion of these options.

Single-Year Procurement

Public Law and Policy

Annual procurement is the acquisition process which results from annual funding. It is sometimes called single-year procurement and is "the way we are forced to do business today. . . [83:29]." As mentioned earlier and cited in an example presented by General Slay, a contract for procurement of a weapon system is not negotiated until receipt of the annual appropriations act which may be different than the proposed budget or the earlier authorizations bill. No attempt to negotiate a contract in advance of the actual appropriations act is made because by law ". . . no officer or employee of the United States shall make or authorize an expenditure from or create or authorize an obligation under any appropriation or fund in excess of the amount available therein;. . .[19:1-7]." Additionally, the full funding policy prohibits contracting for more end items than can be purchased with available funds. The law and official policy coupled with existing fiscal constraints and annual funding effectively limit systems acquisition to annual procurement.

Rationale

As mentioned earlier, there seemed little need for multi-year funding of defense needs in the early years of the United States Government. As things have changed, so have the views of many in government and industry concerning the appropriations process and procedures. The comptrollers rulings in 1904 and 1948 which were cited earlier serve as examples. Other examples can be found in the 1967 House of Representatives and Senate hearings concerning the Multi-year Procurement Bill (HR15789) (93). Several officials voiced approval of multi-year procurement methods; however, it was quite obvious that several congressmen and senators felt serious reservations about the DOD using multi-year procurement to buy weapons. Their prime concern was that the Congress would be locked into either funding the procurements or appropriating funds to cover cancellation charges. More recently a renewed effort has surfaced to provide for multi-year procurement for weapon system acquisition. The 1980 Defense Science Board advocated multi-year procurement to help solve several problems facing the defense industry (18). Witness after witness at the House of Representatives hearings on the capability of the U.S. Defense industrial base stated that multi-year procurement concepts would significantly improve contractor capital investment, thus providing greater efficiency, lower cost and shorter lead times (90). Because of these hearings Representative Daniel has recently introduced a bill which

would amend many of the restrictions currently limiting the use of multi-year procurement (92).

Although there is strong evidence that the annual authorizations and appropriations process causes severe inefficiencies, there remains strong reluctance of Congress to loosen its control over procurement appropriations. This reluctance boils down to the central issue of congressional control over the Department of Defense (64). Indeed, the congress maintains a "string" on all funded government agencies through the annual authorizations and appropriations process (91:41). A discussion of one of the alternatives to annual procurement, multi-year procurement (MYP) follows.

Multi-Year Procurement

Concept

Multi-year procurement has become a generic term ". . . describing situations in which the government contracts, to some degree, for more than the current year requirement [29: definitions]." It is rarely used today for weapon systems acquisition because of regulatory restrictions (83:VII-30). The Defense Acquisition Regulation (DAR) defines multi-year contracting as ". . . a method of acquiring for DOD planned requirements for up to a 5-year period (4 years in the case of maintenance and operation of family housing), without having total funds available at time of award [22:1-322.1(2)]." This point "without having total funds

available at time of award" is the key difference between multi-year funding and full-funding. A multi-year contract under present regulations allows for the situation where only the first year of the contract is initially funded and ". . . the contractor is protected against loss resulting from cancellation by contract provisions allowing for reimbursement of unrecovered nonrecurring costs included in prices for cancelled items [22:1-4322.1(a)]." The DAR continues by limiting the cancellation ceiling to $5 million unless increased by congressional approval. This restriction is the result of the Department of Defense Appropriation Authorization Act, 1976 (91:34).

The standard DAR multi-year contract does not allow for advanced buys of materials or items simply because they offer price breaks. "Items only qualify for advance procurement if they have significantly long production lead times [83:VII-30]."

Additionally, the cancellation ceiling only covers unrecovered non-recurring costs. This prevents the contractor from purchasing large quantities of materials at cost savings and passing the savings on to the government through lower prices. Besides the standard DAR multi-year contract, there are other possible multi-year acquisition strategies which are designed to encourage competition, investment and stability. These strategies are generally called expanded multi-year procurement and include varying degrees of advance funding and cancellation protection (52).

Types/Strategies (Other than Standard)

1. Fully funded front-end multi-year procurement with compressed schedules is the most extreme case. Although not restricted by any laws or regulations, it would require all funds for the entire accelerated program to be appropriated at the beginning of the program. Since all funds would be available, no cancellation ceiling would be required. Maximum savings could result (See Chapter III for cost considerations). It is unlikely that this type of fully funded MYP would be used with major acquisitions because of the large amount of funds that could be tied up for lengthy periods of time. An additional benefit would be earlier system fielding and longer operational life (94:328).

2. A fully funded advance buy MYP would fund all labor and material in advance and fully fund annual requirements per the full funding policy. The cancellation ceiling would include only non-recurring costs since recurring costs are fully funded. On major acquisitions, an increased ceiling would be appropriate to realize production efficiencies through larger capital investments.

3. Incrementally funded advance buy MYP is a fully funded program with termination liability funding for advance labor and material purchases. This approach reduces the governments commitments to future programs and permits more efficient use of budgeted funds.

4. An incrementally funded MYP (no specific funding

for advance buys) funds the entire program on a termination liability basis. Advance buys are authorized but, for the most part, only material is bought with first year money. This method minimizes the government's initial commitment and allows maximum efficient use of funds. This method is also the most drastic departure from the full funding policy.

5. An MYP with an unfunded cancellation ceiling which includes recurring costs would be used for programs with high cancellation ceilings. This approach would allow advance buys and progress payments not in excess of the annual contract funding. It would not require heavy up front funding but would require legislative waivers or law changes. This method also violates the full funding policy.

It should be noted that all of these approaches except the standard DAR MYP are exceptions to current policies and legislative requirements and may require exceptionally high appropriations. Necessary changes to these laws and policies will be discussed later in this chapter. These policies and laws have evolved through many years and will be hard to change. Strong leadership and compelling persuasion will be required from both industry and DOD. The following sections discuss the viewpoints of industry, congress and the DOD.

Industry Viewpoint

There is little doubt that industry views MYP positively. The 1980 Defense Science Board, Summer Study, which

had several defense industry leaders as members[1] expressed solid support for MYP (90:1552). The Board acknowledged the findings of the 1979 Defense Science Board Study on "Reducing the Unit Cost of Equipment" which recommended that DOD should seek multi-year appropriations (Multi-year funding as discussed earlier) but concentrated on a different approach. This approach was directed at multi-year contracts using annual funds because multi-year funding would ". . . exacerbate the current 'bow-wave' problem [90:1621]." The Defense Science Board stated that:

> The principal benefit of such longer-term contracting arrangements is to achieve economies of scale. With the greater assurance of a solid program, contractors have a much greater incentive to invest in productivity measures and to make economical buys from vendors and subcontractors. The savings potential for multi-year contracting is estimated to be from 10 to 15% (in constant dollars). This is based on recent studies, but it reflects the experience of the late 1960's and the early 1970's when multi-year contracting was used fairly extensively. An indirect benefit of the multi-year approach is that it provides a surge potential in the second year and beyond because the materials and suppliers are there if you have to surge [90:1621].

Additionally the Board found that the current limitations on the use of multi-year contracting require unacceptable risks to the defense industry and, therefore, have resulted in only a few multi-year contracts. Specific recommendations were (1) revise DAR 1-322 to include recurring costs in termination liability provisions, (2) repeal the $5 million cancellation ceiling and (3) revise DOD Directive 7200.4 to permit

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[1]Members and Staff of Summer Study Task Force are included in Table 4.

TABLE 4*

Members	Organization	Title
Robert A. Fuhrman Chairman	Lockheed Milliles & Space Company	President
John H. Richardson Vice Chairman	Highes Aircraft Co.	President
Dr. R.D. LeLauer	TRW	Executive V-Pres.
Dr. M. Sutton	Honeywell Defense Systems Division	V-President & General Manager
G.B. Barthold	ALCOA	Man., Tech. Prog.
Dr. Jacques S. Gansler	TASC	V-President
Jerry Junkins	Texas Instruments Equipment Group	V-President, Group Manager
Wallace Brown	Dept. of Commerce	Dir., Office of Industrial Mobil- ization
Richard E. Donnelly Executive Secretary	OUSDR&E	Deputy Dir., Prod. Resources
Staff Support		
James F. Drake	Hughes Aircraft Co.	Corp. Dir., Advanced Program Plans
Robert G. Gibson		Consultant
Robert R. Irwon	TRW Sys. & Energy	Asst. to the Executive V-President
Major Assistance		
Donald D. Malvern	McDonnell Aircraft	Executive V-Pres.
Charles P. Downer	OUSDR&E (AP)	Dir., Defense Industrial Resources Support Office

*Members and Staff of the Task Force (90:1548)

multi-year contracting without requiring full funding.

The Board's feelings on the subject of MYP are summed up well in a statement by Lockheed's Board Chairman, Robert A. Fuhrman, in which he cites single-year contracting as "the biggest single problem we see in the defense business [4]."

Another defense industry group, the Electronic Industries Association (EIA), has gone on record as strongly supporting MYP (33:1-8). In their position paper on the subject they note the constraints of the present procurement system and advocate MYP as ". . . a stable base upon which to build [33:1]." They note, also, that ". . . multi-year contracting has been constrained by the absense of a complimentary multi-year funding process [33:2]." The EIA's paper lists advantages, benefits, and risks associated with MYP. The advantages they list are (1) encourages industry cost saving capital investments, (2) lower material prices through larger quantity buys, (3) encourages maintenance of trained labor for government requirements, (4) better planning, (5) reduced administrative costs and (6) increased price competition (33:3-4).

The EIA's position paper cites the lack of understanding of MYP advantages[2] and, also, regulatory restrictions as reasons for reduced use of MYP in government contracts. The EIA advocated elimination of the current $5 million cancellation

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[2]Regarding MYP understanding, several other studies have also expressed this concern. See references 47, 57, and 95.

ceiling and establishment of a percentage of contract cost (20-30%) ceiling which includes recurring costs such as material and labor. Other recommendations concerned longer than one year congressional funding, support of recent legislative proposals for MYP, and 100% progress payments for paid materials (33:8-9).

Other industry leaders have voiced similar support for the entire concept of MYP. Hughes Aircraft Company President, J. H. Richardson, in a letter to RADM N. P. Ferraro of the Naval Air Systems Command, encourages the Navy to investigate multi-year contracting (77). In this letter, Richardson states that after 10 years of study on the subject of MYP, cost savings from 20-30% could be expected from a three year buy vs. annual procurement. Interestingly, Hughes proposed a multi-year buy for the Phoenix weapon system in 1974 which promised 18% savings but had the offer rejected by the Navy because, among other reasons, they would have a problem "selling it to Congress [77:1]." Their consideration of underwriting the multi-year procurement at their own expense was discarded when their analysis showed that, because of government pricing policies, their profit would be reduced. Hughes Chairman of the Board, Allen Puckett, further advocated MYP and suggested legislative improvements when he addressed the House of Representatives concerning the Nation's defense industrial base (76:10). Additionally, in a letter to former Representative Richard H. Ichord, Puckett "heartily endorses [75:1]" MYP and specifically

addresses the key issues of full funding, the $5 million cancellation ceiling, flat pricing or level unit pricing, and procurement flexibility. The Hughes Company has taken the lead in promoting enhancement of the multi-year concept. It has developed a complete package of legal issues and required legislative/regulatory changes (77:Atch A). Their reasons for this effort are best summed up by their observations that

> . . . the impediments to multi-year contracting are associated with policy, perceived policy, directives or regulations, all of which may be changed with minimum effort, given the commitment to capitalize on the opportunities that longer term contracting would offer [75:3].

Although the Hughes Company has taken the lead in advocating MYP, several other companies have shown significant interest. General Dynamics (GD) Corporation is actively pursuing a multi-year contract for the Air Force F-16 fighter bomber (4; 8). Their Vice President for contracts, Frederick S. Wood, projects 15% savings through a single buy, and the company has supplied supporting data to the F-16 program office which shows, for a ten aircraft per month production schedule, cost savings of $1.883 billion (82; 2). Primary cost savings are realized through the contractors ability to make long term investments in components and raw materials.

The Northrop Company is another example of industry interest in MYP. Their Chairman and Chief Executive Officer recently cited MYP as a key to production economies and industrial efficiency (51:19-22). Northrop's faith in MYP led them to underwrite the risks involved in their multi-year

contract for the B-52 AN/ALQ-155 Power Management System. Cost savings associated with the multi-year contract are documented at $10.6 million with savings being attributed to both economical purchases of material and efficient application of labor[3] (81:Tab A). Although the most efficient procurement would have been through an expanded multi-year contract with a higher than $5 million cancellation ceiling and advanced buy of material, a standard DAR contract was eventually agreed upon because of potential violations of the full funding policy of DODD 7200.4. One of the Air Force's contracting officers involved in the contract negotiations concedes that only because of Northrop's desire for the multi-year contract did they accept the risks associated with the DAR cancellation limit and recurring costs restrictions, thus promoting the multi-year savings (32).

The Aerojet Corporation provides yet another example of both interest and participation in multi-year procurement. At a recent pricing symposium the company expressed the view that MYP can make a good acquisition program even better but cannot make a bad program good (34:1). Additionally, the company spokesman warned that if misapplied MYP could make a good program bad. The Aerojet Corporation is presently participating (in competition with Honeywell, Inc.) in a multi-year contract for the acquisition of 30mm ammunition for the

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[3]Labor efficiency accounted for $.5 million and material economy accounted for $10.1 million.

GAU-8/A gun system, a subsystem of the A-10 aircraft (3). The contract is the standard DAR multi-year type for three years and offers $33.9 million in cost savings over three separate single year contracts. The standard multi-year contract was selected over an expanded multi-year type because of the cancellation exposure and congressional waivers required; however, price submissions by the two companies indicate that the expanded contract would have produced $42.5 million in savings over three separate yearly contracts (3:7). There has been some question over the exact amount actually saved by the MYP since there were some cost elements which were new[4], but the Air Force's purchasing officer for the A-10 systems is convinced that the multi-year contract has provided significant savings regardless of timing (44).

Because there are so many benefits for both sides, industry is overwhelmingly in favor of MYP. There are, however, some reservations. As indicated by the examples cited above, there are certain risks involved with a multi-year contract. Almost all advocates stipulate that their endorsement is based on increasing the cancellation ceilings and including recurring costs in the cancellation charge (31:15). Witness after witness at the 1980 congressional hearings concerning the defense

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[4]The contract specified a shift from government furnished material (GFM) to contractor furnished material (CFM) such as the primer, fuse, flash tubes and high explosive incendiary mix. This shift undoubtably placed additional risk on the contractors and may have caused an additional contingency margin to be added to the price.

industrial base identified these two points as major requirements for advantageous use of MYP in major systems acquisition (91:35-36). Additionally, the witnesses recommended more flexible application of the full funding policy. To guard against the risks associated with longer contract periods, industry leaders also advocate escalation clauses to protect contractors against the uncertainties in inflation, energy, and the cost of capital (33:4).

Because of the overwhelming support of industry and many government officials, the question has been raised as to why we do not utilize MYP more often. The answer to this question has a complicated past because it deals with the views of Congress, DOD, and past administrations. This next section will briefly discuss the congressional viewpoints on the issue of MYP.

Congressional Viewpoint

The current enthusiasm over multi-year procurement is not the first attempt by the DOD to utilize multi-year contracts. Multi-year contracts have been used since the Department of the Army service-tested the concept in the procurement of small motors (5:37; 57:2-3). The emphasis in current attempts to utilize MYP is for major weapon systems which are now most always single-year procurements. These single-year procurements are forced by congressional restriction[5]

[5] $5 million cancellation ceiling, exclusion of recurring cost in the ceiling, and annual appropriations.

and the full funding policy (81). Earlier attempts to use multi-year concepts, however, were directed at the procurement of supplies and services which were funded with annual appropriations (93:7492-7500). The specific goals involved the issuance of multi-year contracts for supplies and services within the United States and overseas. The DOD felt that the annual contracts inhibited competition and drove up costs because many companies were unwilling or unable to take the risk of cancellation after one year, and those that did often underbid their cost in the first year in hopes of recouping them through noncompetitive follow-on contracts (93:7498).

The bill presented to Congress to remedy these perceived problems was the before mentioned Multi-year Procurement Bill, (HR 15789) which was subject to hearings held by the House and Senate Armed Services Committees on several dates in 1967 and 1968. At that time, weapon system procurement appropriations were no-year funds and MYP was being used for some weapon components. This practice was quickly questioned by Congressmen Gubser, Hardy and Pike in the House and Senator Dominick in the Senate (31:18). Their basic reservation concerning the issue involved the DOD use of MYP for weapon systems and, as mentioned earlier, committing present and future congresses to either funding the procurements or funding the cancellation charge. The resulting legislation was a public law 90-378 which allowed multi-year contracting with annual funds for <u>services</u> <u>outside</u> the contiguous 48 states and the District of Columbia (93). This less than

optimal provision resulted from several legal readings from the General Accounting Office (GAO) which did not object to the proposed legislation but advised that operations and maintenance contracts executed and supported under authority of fiscal year appropriations can only be made within the period of their obligation availability (93:7529). The GAO's basic concern was over the obligation of funds which were not available and subsequent violation of the Antideficiency Act[6]. They felt that with sufficient wording, the multi-year contracts would remain legal. Additionally, Congress did not feel that government funds should be tied up in order to cover the contingency of cancellation (93:5726). This feeling in Congress tended to give qualified endorsement to the use of MYP with no-year funds.

During the late 1960's the DOD had little trouble using MYP for acquisition. The appropriations for this purpose were no-year funds and were not restricted by the current full funding policy which was published as DODD 7200.4 in October 1969. There was little reason to challenge the cancellation record of government agencies since few contracts were actually cancelled. Evidence to the effect was produced by a 1965 Logistics Management Institute study which reviewed all (42) multi-year contracts issued prior to 1965 and found that none had been cancelled (57:29). The study also asserted that only

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[6]The Antideficiency Act of 1906 prohibits expenditures in excess of an appropriated amount (39:11-12).

30% of the contracts that could potentially use multi-year procedures were actually issued as such but that administrative savings alone were in excess of $1.25 million (57:22,29).

Beginning with the early 1970's MYP faced a dramatic slow-down. In 1972, the Navy presented Congress with two cancellation charges totaling over $388 million resulting from multi-year shipbuilding contracts (31:20,21). In response to this Congress established a $5 million cancellation ceiling which became law as part of the FY 1973 Armed Forces Authorization Act. This action was the legislator's way of maintaining control over multi-year contracting for weapon systems, and it has effectively eliminated major acquisitions from multi-year procurement. By imposing this restriction Congress had hoped to prevent unfunded liabilities, such as the shipbuilding claims, from occuring after Congress had reviewed and approved the program. The shipbuilding claims, for example, were for unrecovered start-up costs which were to be spread over the entire purchase[7], some of which were cancelled. The claims were not for actual costs of the cancelled items. With regard to these shipbuilding claims, several Congressmen felt that the claims were the result of illegal contracting, however, the GAO supported their legality.

There have been other attempts to liberalize the

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[7]For allowable cancellation charges see the Defense Acquisition Regulation (DAR); reference 22:7-104.17(b).

restrictions on the use of MYP[8] but the restriction which preclude the use of MYP for weapons acquisition still exist. At present there is renewed interest in Congress concerning MYP. As mentioned earlier Representative Dan Daniel introduced a bill[9] in January 1981 which would raise the cancellation ceiling to $100 million and include both recurring and non-recurring costs. The bill has been endorsed by the former commander of the Air Force Systems Command, General Slay (60) and has general approval of many defense industry leaders (74:18-22). It has subsequently been incorporated into the Fiscal 1982 Defense Authorization Bill but is still subject to ammendment by the full House (60:113). The Senate version limits the ceiling to $50 million but allows greater latitude to DOD by not specifying what kinds of procurement may be made under multi-year contracts.

The most heated disputes over the issue have occurred within the House between the Armed Services Committee and the Government Operations Committee (66:26). The Armed Services Committee supports the Daniel Bill provisions (67:198-199), but the Government Operations Committee has chosen to be more restrictive. The Government Operations Committee ammendment retains the $5 million cancellation

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[8]The proposed Federal Acquisition Act of 1977 and the proposed Federal Acquisition Act of 1979 both addressed some of the issues (but not the cancellation ceiling); however, neither were passed (31:21-22).

[9]H.R. 745 Armed Services Procurement Policy Act of 1981; reference 92.

ceiling and would allow multi-year contracting on a larger scale only on a case-by-case basis (30:A-10; 55:197). The committee's reasons for this closely follow the historical stand Congress has maintained on the issue. The committee states "multi-year contracting fences in money, commits future Congresses to particular weapons systems acquisitions and reduces congressional oversight [66:26]." One congressional aid voiced legislative skepticism by submitting that MYP would require a stable five-year defense program with realistic cost estimates and realistic inflation estimates and noting that he hasn't ". . . seen a stable five-year defense program in 14 years [60:113]." Another concern is that the increased multi-year authority granted by the Armed Services Committee would undo the work of the Office of Federal Procurement Policy (a branch of OMB) which is working to develop a uniform government-wide procurement policy (49:227; 50:197).

As the controversy continues in Congress, proponents of multi-year concepts are maintaining their stand that MYP is "the single most important change we can make to address defense industrial base problems . . . [83:VII-27]." The Department of Defense and the General Accounting Office have consistently advocated the prudent use of multi-year contracts. The following is a discussion of their views.

DOD/GAO Position

There is little evidence that would indicate that the

DOD and the individual services have anything but consistently approved of multi-year procurement. From the Army's initial testing of the concept for supplies back in 1961 through the Navy's shipbuilding programs in the late 1960's and early 1970's to the current Air Force initiations for major weapon systems acquisition[10], the DOD has endorsed the concept and, as described earlier, appealed to Congress for more liberal laws and regulations. The present position has not changed.

The position of the Office of the Secretary of Defense (OSD) is best expressed by Dr. William J. Perry, former Under-Secretary of Defense for Research and Engineering (USDR&E), in his statement to the House of Representatives Panel on the Defense Industrial Base (90:1398-1407). In his testimony Dr. Perry discussed longer term commitment and funding as a key element in ". . . achieving enhanced productivity through multi-year contracting for an economic procurement quantity [90:1402]." He described several multi-year alternatives but noted that the present multi-year option prescribed by regulation (DAR) is limited by the $5 million cancellation ceiling. Dr. Perry conceded the deletion of the ceiling would not solve all the problems involved and suggested that the full-funding policy, although still applicable to many programs, should be more flexible and allow advance funding of

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[10]See General Slay's "Legislative and Policy Changes for Multi-year Contracting;" Reference 81.

labor and material for programs considered stable. He pointed out that "few contractors would be willing to incur such investment expenditures without government commitment to fund and pay such costs as they occur. The cost of money is just too high to make this an enticing approach in a number of programs [90:1404]." Dr. Perry also expressed the view that no special statutory authority should be needed to enter into multi-year contracts but that appropriate identification in the annual defense budget submissions to Congress would be sufficient. Incidently, the DOD is currently identifying all multi-year procurement programs with the designation (MYP) (29:Encl 3, p.3). Interestingly, Dr. Perry also renewed the DOD's attempt to gain unlimited[11] multi-year contracting authority for supplies and services funded with annual appropriations. Dr. Perry presented the following criteria for selection of multi-year programs (90:1407):

1. The configuration should be established,
2. the inventory quantity known,
3. the program should be noncontroversial in need and mission, and
4. the requirements included in the Five-year Defense Program.

The current USDR&E, Richard D. DeLauer has continued with the position Dr. Perry presented. He supports MYP because

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[11]As discussed earlier, multi-year contracts with annual appropriations currently are allowed only for service contracts outside the 48 contiguous states (22:1-322.1(d)).

he feels it will encourage industry to make the necessary investments in equipment needed to improve productivity; however, he cautions that the multi-year approach cannot be applied to marginal programs that may change with a changing threat (61:57).

The views of the Department of Defense have recently been officially published by the Deputy Secretary of Defense, Frank Carlucci, in a "Policy Memorandum on Multi-year Procurement" (29). In this memorandum the DOD remains committed to the full funding policy but allows for case-by-case consideration of programs. The memorandum presents the following criteria to aid in what it considers the "management judgement" involved in deciding whether to use or not to use MYP (29:Encl 2):

1. Benefit to the Government
2. Stability of requirement
3. Stability of funding
4. Stable configuration
5. Degree of cost confidence
6. Degree of confidence in contractor capability.

It is apparent, that the present administration is interested in using more multi-year concepts but as Stephen A. Trodden, deputy director for procurement in the Defense Comptroller's Office said recently ". . . how far and how fast we go is arguable. I do not think we should abandon the full funding principle all at once [60:108]."

With respect to the individual services, the Air Force and the Navy have both originated significant initiatives toward expanding MYP for weapons acquisition. General Alton D. Slay, former Commander of the Air Force Systems Command has been a leading advocate of MYP. His statement on the Defense industrial base issues to the Industrial Preparedness Panel of the House Armed Services Committee included numerous advantages of multi-year contracting and presented several Air Force programs which have enjoyed significant savings due to multi-year contracting (83:VII-27,VII-35). Additionally, General Slay proposed changes to existing law and regulations which have subsequently been included in the before mentioned Daniel Bill (81; 92) or addressed in the Department of Defense Policy Memorandum on Multi-year Procurement (29).

Another Air Force leader, General Bryce Poe II, Commander Air Force Logistics Command (AFLC), has also testified before the House Armed Services Committee Panel on the Defense Industrial Base in full support of MYP (90:911-924). General Poe agreed with all the initiatives of General Slay and produced figures which further attested to the cost saving merits of MYP. Interestingly, but not surprising, General Poe returned to the subject of multi-year contracts with annual appropriations for supplies and services within the contiguous 48 states. Because the AFLC is responsible for logistics support of Air Force units and certain system acquisitions,

the command feels it could surely benefit from MYP of supplies as services currently funded through single-year appropriations. Also in his statement, General Poe advanced an important multi-year concept he termed expenditure funding. This concept was developed to alleviate the cost growth problems on the TR-1 aircraft program caused by production stretchout decisions. Under this concept, which would violate the full funding policy, a quantity of items would be ordered and the contractor's costs would be funded on a yearly basis. No unfunded cancellation liability would result; however, delivery of end items may not be guaranteed until later years. General Poe contends that his command could save $95 million on the TR-1 through this multi-year procedure and allow for the purchase of 16 airframes instead of the 10 possible under the full funding method.

One final comment concerning Air Force endorsement of MYP is in order. In interviews with several key managers of the Aeronautical Systems Division (ASD) at Wright-Patterson Air Force Base, the central theme was that MYP was not merely a contracting method but an acquisition strategy (17; 46; 80). Each officer acknowledged the advantages of a correctly applied multi-year procurement, but each one also considered full funding as "good business" procedure. ASD's Vice Commander, General Saxer suggested that we may have gotten more for our money if we had fully funded each program one at a time at the most economically efficient rates of

production (80). General Harbour, Deputy for Airlift and Trainer Systems felt that full funding and annual funding were an "acid test" through which only good programs would pass (46). He also warned that inappropriate use of MYP could place future beneficial use of multi-year concepts in jeopardy.

The Navy has not taken a back seat in advocating MYP. Admiral A. J. Whittle, Jr., Commander of the Naval Material Command has also testified before the House Armed Services Committee Panel on the Defense Industrial Base (90:682-697). He endorsed the Defense Science Board's position on MYP and specifically recommended raising the cancellation ceiling. Interestingly, Admiral Whittle cautioned that multi-year contracting should not be used across program decision points (DSARC), nor within the technology base. The Navy has employed multi-year contracts for several years and claims from 6% to 35% savings over single-year procurements on four example programs[12] (78:19). The Navy's record on the number of multi-year contracts placed additionally emphasizes their endorsement. From 1976 through the middle of 1980 the Navy placed 684 multi-year contracts as compared to 201 for the Army and 212 for the Air Force (47:18). Conversely, the Army's value of first years obligation under MYP contracts as a percent of

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[12]The example programs are (1) the MK-46 Torpedo, (2) the AN/WSC-3 Satellite Communications Set, (3) the AN/SQQ-23B Sonar System, and (4) the TPS-59 Radar.

total averaged 1.2% for the nearly five year period as compared to .53% for the Navy and .32% for the Air Force (47:19).

One last comment from the perspective of past experience is in order. In an anlysis of factors associated with successful programs, a recent study questioned 110 individuals who had been in leading positions in Air Force acquisition since 1965 (96:7-9). A correlation of responses concerning the importance of causes of success produced the following causes in order of importance (96:57-60):

1. Strict adherence to system performance.
2. Funding was consistent.
3. The system was supported by HQ USAF.
4. The requirement was responsive to the threat.
5. The contractor demonstrated excellence.

The list of causes appears to agree nicely with the criteria previously mentioned. Furthermore, the second most important cause, funding was consistent, is a primary attribute of multi-year procurement. From this brief analysis, it does appear that MYP has excellent potential for making a good program better.

Turning now to the position of the GAO on MYP, it is apparent that the Comptroller General has consistently advocated the cautious and prudent use of multi-year contracting methods. During the 1960's, as discussed earlier, the GAO testified in support of liberalized laws for DOD use of MYP. Since then the GAO has gone on record in several other

instances in favor of expanded use of MYP. In 1978 the GAO, in a report to Congress entitled Federal Agencies Should Be Given General Multiyear Contracting Authority For Supplies And Services, concluded that

> . . . the advantages of the multiyear procurement technique identified by agency officials outweigh the disadvantages and that the disadvantages can be minimized and control enhanced through adherence to appropriate criteria for use of multi-year procurement. We recommend that the Congress enact legislation authorizing multi-year procurement for Federal agencies. . . [9:19].

This particular report specifically addressed the legislative restrictions on annual appropriations which preclude the DOD's use of multi-year contracts for supplies and services within the 48 contiguous states. The report also identified several instances where significant cost savings were probable (9:8-10). Savings, exclusive of administrative cost savings, of 21% were identified.

In two other reports issued in 1979, the GAO continued its support of multi-year concepts. The first was issued in September and addressed to the Chairman of the Senate Budget Committee, Senator Edmond Muskie (13). It was sent in response to a request by Senator Muskie for GAO help in determining the extent to which reform in procurement practices has been implemented by the DOD. The Comptroller General made several suggestions for improving major weapon systems procurement practices, one of which was to "make greater use of multiyear funding [13:4]." The report cited annual funding as a contributor to uncertainty which inhibits contractors from

making substantial capital investments that could keep costs down. Additionally, the report agreed with the many other authorities who saw several benefits to multi-year funding[13]. These benefits are:

1. Greater stability,

2. improved production costs through greater contractor investment,

3. improved production costs through more favorable competitive negotiations, and

4. lower prices due to more economic purchases of material.

In the GAO's second 1979 report addressing the subject, entitled Impediments to Reducing the Costs of Weapon Systems, the agency tied MYP restrictions to congressional appropriations. Citing the period 1968-1973, when the DOD was able to use no-year funds for procurement, the report reference savings in excess of $52 million resulting from the use of multi-year contracting. The emphasis regarding the issue appeared to be that multi-year contracting and associated savings could again be possible if the DOD was provided no-year or multiple-year funds for procurement. As has been discussed earlier, the DOD presently receives multiple-year appropriations for procurement,

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[13]Multi-year funding specifically allows for multi-year procurement because it provides funds for more than one program year. Multi-year funding, however, requires very large first year appropriations which, because of budget constraints, makes it impractical and unrealistic (94:530).

but because of annual funding, the full funding policy, the $5 million cancellation ceiling, and realistic budgetary constraints, the DOD is effectively limited to single-year procurement.

Most recently, in a report entitled Multiyear Authorizations for Research and Development, the GAO addresses some of the problems associated with the annual authorizations process (12:4-5). The report specifically addresses several of the negative effects of the annual authorization process:

1. The current annual process does not provide sufficient time to establish priorities.

2. It inhibits long range planning.

3. Time constraints prevent large scale viewing of cross-agency programs.

4. It adversely affects program stability.

5. It makes important but long term R&D efforts vulnerable to budget cuts and program interruptions.

Although addressing the peculiar problems of R&D the report confirms the many disadvantages of the annual authorizations and appropriations process. With this and previous reports, this cost conscious agency joins the many other advocates of legislative and regulatory change toward expanded use of multi-year concepts.

Current Status

The preceeding discussion of the many viewpoints toward MYP indicates that there are numerous issues to be

resolved. Without a doubt, there are advantages associated with MYP, but there are also some risks involved. The advantages and risks will be assessed in a later chapter; however, it is important to note that significant cost savings will involve risks. Additionally, the cost of flexibility is not light. The current legislative and departmental activity concerning the extent to which multi-year concepts are adopted is undoubtably a benefit/risk analysis which should ultimately provide for significant cost savings at acceptable risks (16:13-17).

As of the writing of this research paper, the current restrictions of the Defense Acquisition Regulation, annual funding, and the full funding policy still apply. Exceptions are being considered on a case-by-case basis, however, in light of current initiatives, expanded authority for MYP seems eminent.

CHAPTER III

PROGRAM COST ELEMENTS

The overriding concern of the procurement agency cost analyst is the identification of those elements of the total cost equation which can be reasonably assessed and predicted under conditions of uncertainty (37:71).

The term "cost" in itself bears a significant amount of uncertainty in that it is a multi-faceted term which has appropriate meaning only with respect to specific frames of reference (63:4-29). Table 5 presents various types of cost with respect to different frames of reference. As can be seen in Table 5, types of cost are not mutually exclusive. Labor and material (descriptive) may be direct or indirect (location). Direct and indirect costs are accounting terms for manufacturing cost elements (48:31). Accounting costs may be classified as related to a specific discipline or functional area. Notice that within the functional classification, costs are oriented to many of the integral parts of the acquisition process. This interdependence suggests that identification of the specific meaning of a cost element is crucial in the managerial decision process. Martin has formulated a generalized definition of cost from numerous studies:

From a generic standpoint cost may be defined as a "multiple-faceted term which has meaning only when associated with a specific frame of reference. Actual cost (accrued and disbursed) generally involves the payment for a product and/or service, (includes both barter and monetary transactions). The term relates to the supply segment of the market. Exceptions to actual cost which must be considered are "social, opportunity, and estimated costs [63:4-31]."

TABLE 5

Types of Cost

Discipline	Functional	Frequency of Occurrence	Decision Choice
Economic Social Political Accounting	Accounting Economic Engineering Procurement Maintenance Production Factory Manufacturing Distribution R&D Finance Administration Marketing	Recurring Current-Year Next-Year Monthly Annual	Opportunity Alternative Incremental Marginal Relevant Additional Differential Avoidable Out-of-Pocket Replacement Imputed
Behavior	**Time**	**Location**	**Descriptive**
Fixed Variable Semi-Variable Marginal Total Average Joint Common Controllable	Sunk Historical Past Future Experiential Expired	Internal External Direct Indirect Average Total	Labor Material Overhead Personnel Operating Manpower Construction Design Real Actual Unique Common Joint Prime Conversion Budgeted

[63:4-30]

The above mentioned definition of cost emphasizes the accounting standpoint and highlights the idea that actual

costs are historical costs that impact decision making for the future. The Defense Acquisition Regulation (DAR) specifies that current cost estimates should be compared with the following (22:3-807.2(b)(3)):

1. Actual costs previously incurred by the contractor or offeror;

2. Either his last prior cost estimate or a series of prior estimates for the same or similar items;

3. Current cost estimates from other possible sources;

4. Prior estimates or historical costs of other contractors manufacturing the same or similar items; and

5. Forecasts or planned expenditures.

The DAR further specifies that "an adequate cost analysis must include an evaluation of trends and changes in circumstances, if any, and their effect on future costs [22:3-807.2(4)]."

Previous editions of the DAR recognized seven general cost categories (73:15). These cost categories[1] were direct material (DM), direct engineering labor (EL), direct

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[1]The aircraft industry generally uses the following cost elements for production(56:1). The elements may be transformed into the cost categories used in this research as indicated by the symbols in parentheses:

Manufacturing Labor (ML)
Manufacturing Material (DM)
Engineering (Sustaining) (EL)
Tooling (OD)
Quality Control (OD)
Manufacturing Facilities (MO), (EO), & (G&A)

A detailed discussion of cost elements used in the aircraft industry may be found in reference 36 of the bibliography.

manufacturing labor (ML), other direct costs (OD), engineering overhead (EO), manufacturing overhead (MO) and general and administrative costs (G&A). The current DAR approaches the subject of cost groupings in more general terms by identifying direct and indirect costs and providing guidance in the form of the following statement:

> Composition of Total Cost. The total cost of a contract is the sum of the allowable direct and indirect costs allocable to the contract, incurred or to be incurred, less any allocable credits. In ascertaining what constitutes costs, any generally accepted method of determining or estimating costs that is equitable under the circumstances may be used, including standard costs properly adjusted for applicable variances [22:15-201.1].

Exact definitions and specific cost groupings should be governed by practical considerations according to individual management practices and cost accounting systems of the contractor (22:15-201.2). A basic definition of a cost accounting system which allows the grouping of costs into the same categories previously mentioned is:

> . . . The extension of the systematic recording of financial transactions reflected in the general accounting system and controlled by or reconciled thereto, for the purpose of disclosing the material, labor and burden costs of manufacturing and selling a product [88:282].

With this definition, the seven categories of costs can be used to establish the Total Cost equation:

$$TC = DM + EL + ML + OD + EO + MO + G\&A$$

This Total Cost equation can be used to evaluate the cost impact of a specific decision and in particular the procurement strategy involving single-year or multi-year

concepts. Separating the categories into either fixed or variable cost groupings further refines the analysis thereby allowing the application of certain cost behavior patterns to relevant areas (48:336-353).

The following discussion of the cost categories is intended to provide general insight into their composition. Examples are used to demonstrate certain characteristics.

Direct Costs

"A direct cost is any cost which can be identified specifically with a particular final cost objective [22:15-202(A)]."

A direct cost is classified as such if it is physically observable as being identified with or traceable to the finished good (cost objective) in an economically feasible manner (48:28). Direct costs are not limited, however, to items which are incorporated in the end product as material or labor (22:15-109(f)). These other direct costs are charged directly to the job or contract and must be solely identifiable with that specific job or contract. Almost any cost may be charged directly to the contract provided there is no conflict with related provisions of the contract or applicable regulations such as DAR and the Cost Accounting Standards. Examples of these other direct costs are special tooling and test equipment, starting load costs, and special packing (88:336-342).

In contrast to direct costs, indirect costs are those remaining to be allocated to the cost objective after the direct material, labor, and other direct costs have been allocated. The primary distinction is the method by which the costs are allocated (48:28). For direct costs, the cost input must be traceable to the product or cost objective. Furthermore, these costs are allocated based on the amount used in that cost objective.

Labor

Direct labor generally possesses the following characteristics (88:330):

1. It is expended directly on a product and results in some change to raw material.

2. The amount so expended on various products must be of sufficient extent to warrant identification and measurement.

3. The identification and measurement must be readily and inexpensively accomplished.

All other labor costs incurred by the contractor are termed indirect labor costs. The distinction between direct and indirect labor varies among industries and within industries. The basic requirement is that "all costs incurred for the same purpose, in like circumstances, are either direct costs only or indirect costs only with respect to the final cost objective [15:402.40]." Furthermore, cost estimates should be consistent with the contractors cost accounting practices

used in accumulating and reporting costs (15:401.20). This requirement ties the contractor's cost accounting system directly to his cost estimating procedures. The important point is that the contractor be consistent when determining his direct and indirect costs and their allocation to the cost objective. Examples of direct labor are fabricating, reworking, assembly, and quality control labor (36:63,80).

The specific procurement strategy, either annual or multi-year, has a direct impact on the direct labor costs assigned to the cost objective. This impact encompasses labor efficiency, labor learning or improvement, and the inflationary effect on labor costs.

Labor efficiency is often considered synonymous with labor learning or improvement; however, for the purposes of this discussion, labor efficiency will be treated in the context of planned requirements. As mentioned earlier, annual procurement results in year-to-year contracts for end-item quantities which are dependent on congressional authorizations and appropriations. This annual process works to the detriment of good production planning because "the prime requirement for efficient production--a stable, fairly long production run--is usually lacking . . .[53:8]." The contractor makes plans to produce at one rate and plans his labor force accordingly. If subsequent years requirements are different than previous years, the contractor is forced to adjust his work force. In one documented case in which

an aircraft company increased its production rate rapidly, intensified recruiting resulted in less than half the workers hired developing into normally productive workers (53:8). In the case of lower than anticipated production, trained labor is either used inefficiently or released. With either option, the result is a costly labor force producing at suboptimal levels, or in the case of the released workers, costly retraining should production requirements increase.

Another factor involved with labor efficiency is the company's investment in labor saving high technology equipment. If the contractor cannot be sure of a continuing requirement through several years he will be much less likely to invest sufficient capital into such improvements (76:9). The annual procurement process plays a prominent role in this dilemma because there is no guarantee that a continuing contract will be issued, much less a guarantee of production rate.

Multi-year procurement which guarantees a continuous contract (and cancellation protection) would stimulate technology investment. An example is the new Technology Modernization Program instituted by the Air Force Systems Command and General Dynamics (GD) Corporation (4:46B-I). Prompted by the prospect of a multi-year procurement of the F-16 fighter and a $25 million investment by the Air Force, GD has spent four times that amount to design and install computerized production equipment at the company's St. Louis

plant. The former Deputy Under Secretary of Defense for Acquisition Policy, Dale W. Church, declares ". . . we haven't taken advantage of all that money invested [4:46B-I]" because annual contracting has led to yearly juggling of production rates which has foiled efforts to establish stable long-term production schedules.

Labor learning or improvement will also suffer with requirements fluctuations resulting from annual procurement. Labor learning is a term commonly used to explain improved productivity from start to finish in a production run. It was developed prior to and during World War II in an attempt to predict cost, estimate manpower requirements, and establish production schedules for an aircraft industry which was becoming increasingly complex (87:I-4). The basic learning-curve theory holds that each time the quantity of end items produced doubles, the time required is reduced to a particular percent of the previous time (87:II-1). For example, if the time to produce the first item was 20 days and the percent (learning curve slope) is 80, the time required to produce the second item will be 16 days, the fourth item 12.8 days, the eighth item 10.2 days, and so forth. The important aspect of this theory is that a lower curve slope indicates a greater rate of improvement and that the slope is highly dependent on many factors beside the individual worker's learning (59:8-10). Some of these factors which are affected by annual procurement are the following (87:I-6):

1. Length of production run.

2. Availability of trained manpower.

3. Number of schedule changes.

4. Availability of high technology equipment.

Each of these factors is aggravated by annual procurement, thus resulting in a lower rate of improvement and higher costs.

Multi-year procurement, because of its longer term commitments would enhance the rate of improvement because (1) production runs would enjoy longer periods without disruption, (2) trained manpower could be retained in more stable programs, (3) yearly schedule changes would not be caused by funding changes, and (4) contractor investments in high technology equipment would be stimulated.

Inflation and direct labor costs are related to the length of time the production of a given quantity spans (36:67). If a given quantity, such as 500 units, is to be procured at a rate of 100 per year, the lot will be procured in five years, and inflation will have increased the labor costs for each year. However, if the contractor was allowed to produce at a rate of 250 each year, plant capacity and budgetary constraints permitting, inflation would affect labor cost for only two years. The 100 per year example is a fair example of annual procurement as it is being done now. Multi-year procurement would allow situations similar to the 250 per year example.

Several studies on the effect of rate on manufacturing

cost have found no general relationship between rate and direct labor costs (36; 53), however, they have recognized the cost sensitivity of labor associated with set-up or tear down, training, and inflation. It is quite plausible that each of these cost influences can be minimized and cost savings of 5-45% from labor efficiencies realized with correct application of multi-year procurement concepts (90:826).

Materials

Direct materials should conform to the following characteristics (88:300):

1. The materials should enter into or become a part of the product or process or the appurtenances or accessories thereof.

2. The quantities of such materials, used on specific processes or products, should be determinable and measurable.

3. The identification and measurement of such materials, as to specific processes or products, should be expedient and not disproportionately expensive.

Materials which do not conform to these characteristics but which are incurred for the specific cost objective are termed indirect materials or supplies.

Direct material costs may include such costs incurred for raw materials, parts, sub-assemblies, and components which are purchased or manufactured for the specific contract and are charged to the contract (22:15-205.22). The allocation of these costs may vary depending on the specific

contractors accounting system.

Direct materials offer the greatest potential for savings under multi-year procurement (90:825). The Air Force Systems Command (AFSC) has found that 40-85% of the total savings from a multi-year contract can be through economic lot buys of direct materials ranging from raw metal to complete sub-assemblies. Interestingly, the F-16 System Program Office has determined that the majority of savings come from the ability to make long term commitments with no change in rate of component delivery[2] (82:Atch 3). Inflation avoidance is significant also, with 20-55% of total savings attributed to early purchase (buy out) of required materials. The higher percentage savings are especially possible at optimum production rates--rates which are possible under a multi-year buy. The proposed F-16 MYP attributes savings of nearly $635 million[3] of the total savings of $835 million to economic order quantities and inflation avoidance (82:Atch 3). In another Air Force program, the B-52-AN/ALQ-155 Power Management System, which was mentioned earlier $10.1 million of the total savings of $10.6 million was attributed to economic material buys.

The learning or improvement curve for material also

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[2]This fact supports the contention that MYP has a significant effect on sub-prime contractors also.

[3]FY 80 dollars. In then-year dollars the amount is $1.418 billion.

is affected in the same manner as was labor. Instability precipitated by annaul buys degrades the percentage of improvement. As discussed earlier, annual procurement is the prime reason cost savings in materials are not now realized. Contractors and sub-contractors are not confident enough that future year contracts will be awarded to them and, therefore, do not stock up on many materials nor do they commit to quantity purchases of them (4:46B-I). The two strongest reasons are that the cost of capital is just too high and the investments are not protected in case of cancellation.

Other Direct Costs

Other direct costs are costs which conform to the requirements of direct costs but which are neither material nor labor. Examples of these costs are, as mentioned earlier, special tooling, starting load costs, and packing costs. Additional examples are rearrangement costs, travel expenses, consultant fees, overtime and shift premium pay, and bidding expenses (88:344). Some of these examples have direct impact on the total cost equation with respect to the procurement strategy (single-year vs multi-year).

When a production run is long and stable, the contractor has the opportunity to plan for optimal plant layouts and setups, steady production rates, efficient personnel hiring and scheduling, efficient production controls, and efficient use of special tooling. A long stable run under one contract also eliminates the requirement for recurring

bids and proposals. Without addressing each possible item which might be classified as other direct costs, the implications seem clear that annual procurement adversely affects optimal planning and production and consequently affects other direct costs. Two specific examples should serve to illustrate: Starting load costs and overtime/shift premium pay.

Starting load costs are costs associated with initial set-up in the preparation for production and certain additional charges from early stages of production (88:341). Costs which qualify for starting load are such items as set-up labor, personnel recruitment and hiring costs, initial training costs, initial production planning costs, and charges related to early inefficiency. Although each of these items may not be required in their entirety at the advent of each yearly contract, some will be required and will result in additional costs. A multi-year contract would reduce these costs to a one time charge to the contract.

Overtime and shift premium pay may be charged to the contract ". . . consistent with contract delivery and performance requirements [88:333]." Although the government specifies that overtime should be minimized, it does not restrict extra pay shifts or multi-shifts (88:333). The impact on total cost is that, without long run planning provided by multi-year agreements, production may require these added expenses and result in higher unit prices.

Annual contracts with their associated quantity increases and decreases may result in these additional costs.

Indirect Costs

Indirect costs are those costs which do not qualify as direct costs but are incurred in part for the specific cost objective. These indirect costs are usually incurred by operations geared toward several cost objectives, one of which is the specific contract cost objective (15:400.1). A direct cost of minor dollar amount may be treated as an indirect cost for practicality if consistently applied to all final cost objectives, and the treatment provides essentially the same results as if the cost had been charged directly (22:15-202(b)). Indirect costs are normally termed overhead or burden (88:346-361). Overhead is typically separated into three generally accepted categories mentioned earlier: Manufacturing overhead, engineering overhead, and general and administrative overhead. These overhead costs must be allocated or charged to the cost objective on the basis of benefits accrued to that objective and must be consistant throughout the base period or periods of the contract (22:15-203).

Indirect costs by their very definition cannot be directly identified in the product and therefore are charged to the product contract through a portion of the unit price. This portion of the price is sensitive to rate and/or length

of production (36:88-92). Because indirect costs can be fixed or variable, the impact of a procurement strategy on the unit price will be addressed later under the heading of "Fixed Capacity Costs."

Manufacturing Overhead

Manufacturing overhead includes all costs other than direct costs which are ". . . incurred within the factory, necessary to produce the product and maintain the plant in an efficient condition for manufacturing . . . [88:361]." Some examples of manufacturing overhead are indirect labor and materials, supplies such as sandpaper and lubricants, material handling, idle time, factory rent, repairs, property taxes, insurance, and depreciation.

Engineering Overhead

Engineering overhead consists of the indirect costs associated with (1) planning the most efficient plant layout, over-all methods of production and related efforts (production engineering) and (2) the search for new products and improvement of existing products (research and development) (88:420-422). Examples of engineering overhead are essentially the same as manufacturing overhead except that they are associated solely with production engineering or research and development. Other possible examples include performance engineering costs, independent research and development costs, and bid and proposal costs.

General and Administrative Expenses

General and administrative expenses include all the necessary costs of doing business except manufacturing and engineering. They are incurred by the business unit as a whole and do not include expenses which can be associated more directly with a particular cost objective than with a cost input (15:410.30). Examples of general and administrative expenses are travel costs, personnel administrative expenses, home office expenses, data processing expenses, and bid and proposal expenses. Note that bid and proposal expenses may be classified as either overhead or general and administrative expenses. The determination of which classification is appropriate is largely a function of the contractor's accounting system. The cost must be identifiable to all cost objectives and allocated to each based on consistent and equitable application of the input base throughout the accounting period (15:410.50).

Fixed and Variable Costs

Volume of Work Relationship

The concepts of fixed and variable costs are used to explain how total cost changes in relation to fluctuations in the activity or volume of a chosen cost objective (48:21). If a given cost changes in total with volume it is variable; if it remains constant in total over a specific time period regardless of volume, it is fixed. Generally,

the variable cost is constant per unit, whereas the unit fixed costs vary with volume.

Fixed Capacity Costs

Fixed capacity costs are those costs associated with establishing and maintaining a business capacity. These costs include those of the physical plant and the necessary managerial staff and are incurred regardless of the volume of work being performed. For a large production firm, these costs can be significant. A recent study performed for the 1980 Defense Science Board discovered that among eleven DOD Systems now in production, thirty percent of the price of the contracts was due to fixed and semi-fixed costs. Furthermore, overhead costs tended to increase from year to year proportional to material, labor, and other end item allocation bases (90:1464-1465). Because fixed overhead expenses are allocated indirect expenses, per-unit costs will be dependent on production rate (48:86-89). This fact has significant impact on the procurement strategy decision.

Most contractors prefer to utilize their facilities at their optimal efficiency (77:Atch A). By doing this they are able to realize economies of scale and remain competitive in the market. A simple example should illustrate the importance of fixed capacity costs with respect to price. Consider a contractor who has annual fixed costs of $500 million. His plant capacity would allow the production of 500 units per year with each unit assuming $1 million of

the fixed capacity costs. Assuming that fixed costs are 30%[4] of the price of the unit, the unit price would be $3.33 million. Now if the contractor was forced to cut production to one half of capacity or 250 units, each unit would have to assume $2 million of the fixed price and the price per unit increases to $4.33 million. This type of reduction due to annual contracting is not uncommon. An example concerning the F-14 was presented in Chapter I. Multi-year procurement could significantly reduce these stretch-out costs by stabilizing the program, reducing direct costs, and permitting the contractor to produce at his most efficient rate. It could be done without increasing the funding profile. Indeed, one AFSC multi-year proposal for the F-16 fighter projected savings of $860 million without a single increase in funding over the present annual buy profile. The projected funding requirements are reproduced in Table 6.

Relationship to Direct and Indirect Costs

By their very nature, direct labor and direct material costs are variable. They are identifiable or traceable to the final cost objective and therefore, directly related to the volume of that objective. Other direct costs do not fluctuate

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[4]This figure is based on the previously mentioned study which examined several recent contracts for defense systems. These contractors were most likely not operating at capacity. A recent publication places average aircraft industry production at only 55% of its one-shift capability (41:170).

TABLE 6

F-16

Funding Requirements
(TY$ in Millions)*

Fiscal Year	Annual Buy Funds	Multi-Year Funds	Savings
82	$1,087	$1,087	$ -
83	1,359	1,253	106
84	1,313	1,239	74
85	1,340	1,224	116
86	1,338	1,214	124
87	1,369	1,261	108
88	1,315	1,189	126
89	1,154	1,038	116
90	263	173	90
	$10,538	$9,678	$860

*Dollar figures include airframe and support equipment and exclude engines and spares.
(82:Appendix B)

directly with activity and, hence, are not strictly variable; however, they are not fixed either since they do not remain constant regardless of volume. An example of other direct costs is rate tooling which is used to sustain a predetermined peak production rate. If the rate of production exceeds the predetermined rate, more tooling is required forcing the tooling cost to vary upward.

Indirect cost can be either fixed or variable. The primary determinate is whether the indirect costs allocated to the cost objective vary proportionately to the level of activity or volume of work. If the indirect costs do not change significantly with the volume of work they are fixed. These fixed costs vary only with respect to time and must be

allocated to the product regardless of volume. Obviously, if the volume of work is small, the portion of fixed costs allocated to each unit produced will be larger, resulting in a higher price per unit. This fact has been identified as a major contributor to additional costs (cost growth) due to program stretchout (73:28).

A recent paper demonstrates the impact that production rates and program length have on the total production costs and the per unit costs (7). The paper derived a model (from actual and projected data points) which facilitates movement up and down a rate/cost trend line[5]. The model is represented by the following equation:

$$\text{New Unit Cost} = \text{Present Unit Cost} \times \left(\frac{\text{New Rate}}{\text{Present Rate}}\right)^{-0.19}$$

The coefficient (-0.19) represents a slope of approximately 87.7% for the rate/cost curve. Using a theoretical $15 million airplane (cost per airplane at a yearly production rate of 48), the authors demonstrate that, if the yearly production rate is reduced from 48 to 24, the new per unit cost of the airplane is $17.1 million, and total program cost for 500 airplanes increases by $1.05 billion.

Summary

The previous discussion of program costs elements and

[5]This rate/cost trend line is similar to the improvement curve discussed earlier.

how they are affected by annual and multi-year procurement has attempted to shed some light on the many factors influenced by procurement strategies for more economic weapon system purchases. Based on this information, the following conclusions regarding MYP can be summarized:

1. Direct labor costs can be reduced by efficient planning, utilization, and investment; facilitated learning or improvement; and labor wage inflation avoidance.

2. Direct material costs can be reduced by economic lot buys, advanced purchase commitments, and inflation avoidance.

3. Other direct costs can be reduced by more stable longer production runs and the reduction of redundent direct charges.

4. Unit prices can be reduced by more optimal use of facilities thereby reducing the per unit costs allocated from fixed investments.

5. Stretchout costs can be eliminated or reduced by efficient and optimal use of existing funding.

A final caveat to the above analysis is in order. Multi-year concepts can save money, but if misapplied or mismanaged they can also cost more money. Any cost savings attributed to MYP will occur only if appropriate programs are screened for stability and negotiated and managed properly. The next chapter will focus on this point.

CHAPTER IV

MODEL DEVELOPMENT

Multi-Year Concept Analysis

The previous chapters presented a discussion of current annual and multi-year procurement practices, principle viewpoints, and cost considerations. The general mood of most persons in positions of authority is theoretical approval--ranging from qualified endorsement to cautious reservation. This range of approval is due, in most part, to the particular perspective from which the authority views the benefits and risks and the attendant advantages and disadvantages. In many cases, an advantage to one concern is possibly a disadvantage to another. As an example, consider the industry which views a long stable production run resulting from a government multi-year commitment as advantageous because it can improve efficiency, economically purchase materials, increase its competitive stand, lower prices and ultimately increase profits. From the government viewpoint (DOD and Congress) the lower prices are an advantage but an overriding disadvantage may be the loss of flexibility in funding. This analysis of advantages, disadvantages, and criteria, therefore, will be primarily from the viewpoint of the government; however, the viewpoints of all agencies

within the government may not necessarily agree. The areas of agreement and disagreement have been partially covered in Chapter II and will be further developed in this chapter.

Advantages

Much of what has been the viewpoint of the government for many years is embodied in the Defense Acquisition Regulation (DAR) which is the culmination of policy and legislation. The DAR encourages multi-year contracting when one or more of the following advantages can be realized (22:1-322):

1. Lower costs;
2. Enhancement of standardization;
3. Reduction of administrative burden in the placement and administration of contracts;
4. Substantial continuity of production or performance, thus avoiding annual startup costs, preproduction testing costs, make-ready expenses, and phaseout costs;
5. Stabilization of work forces;
6. Avoidance of the need for establishing and "proving out" quality control techniques and procedures for a new contract each year;
7. Broadening the competitive base with opportunity for participation by firms not otherwise willing or able to compete for lesser quantities, particularly in cases involving high startup costs; and
8. Implementation of the Industrial Preparedness Program for planned items with planned producers.

It should be noted that six out of the eight advantages

involve costs (1,3,4,5,6,7) and the other two have secondary cost considerations[1]. There is little doubt that escalating cost of modern weapons is a primary driving force in the current campaign for increased multi-year procurement. Some DOD officials estimate that multi-year savings could have been as high as $5 billion or more in the $50 billion procurement budget for fiscal year 1981 (4:46 B-I). General Slay, cited earlier as a strong advocate of MYP, estimated savings of $100 million on just two Air Force Systems Command programs--the Air Launched Cruise Missile and the Maverick Heat-seeking Missile. The many factors and cost elements which contribute to these savings were covered in Chapter III. The possibility of higher costs also exists and will be addressed in a subsequent discussion on disadvantages.

The second advantage cited by the DAR is standardization. This is no small factor because standardization affects not only systems management, training and support, but also field losses and mission accomplishment. Longer, stable production runs by a single contractor should ultimately result in optimum engineering, continuous quality control, lower defect rates, and higher product quality. These returns can be enhanced further by increased capital investment stimulated by multi-year commitments.

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[1] Enhanced standardization reduces costs associated with management, training and support of a weapon system; and industrial preparedness can reduce costs of administration, control and start-ups of annual contracts.

One advantage closely related to standardization, but on the other side of the coin, is the impact of MYP on value engineering (VE). Value engineering is

> . . . an intensive appraisal of all the elements of the design, manufacture, or construction, procurement, inspection, installation, and maintenance of an item and its components, including the applicable specifications and operational requirements, in order to achieve the necessary performance, maintainability, and reliability of the item at minimum cost [22:3-406.3].

Many contractors consider annual contracts too short in duration to facilitate an extensive VE effort (57:83). Interestingly, value engineering may work counter to standardization depending on the extent to which product improvements vary the end item characteristics with respect to earlier produced items.

The seventh factor noted by the DAR is increased competition which is generated because firms[2] that were not willing or able to participate in annual buys due to high start-up costs may find a larger multi-year quantity acceptable. There are obvious cost considerations in increased competition which have been previously discussed but there are other advantages to increased competition. One important advantage is the competitive drive for new technology in both product and methods. Increasing fuel efficiency in todays automobiles, while certainly prompted by rising fuel costs, is surely induced by competition. Another advantage of competition is the existence of an industrial base ready for crisis. This

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[2]Specifically, small businesses may gain the opportunity to enter competition (64:16).

is especially important at the subcontractor levels (91:12-17). Many subcontractors have removed themselves from the defense industry because annual contracting presents an unstable environment in which the risks of "erratic procurement practices [91:14]" are unreasonable. A stabilized work force mentioned by the DAR as an advantage, although primarily cost oriented, also has an impact on industrial preparedness. The recent Defense Science Board stated that it believed that a stable Five Year Defense Plan supported in part by enhanced use of multi-year procurement would be an important first step toward industrial base improvement (91:22).

The eighth advantage cited by the DAR pertains to the maintenance of an industrial base capable of supporting the continuing needs of existing weapon systems already in the field. MYP for these systems is logical since their technology is stable and unlikely to change. Of equal importance is the surge capability of the Defense industrial base. The Hughes Aircraft Company, in a letter to the Navy, notes that a significant positive factor of multi-year contracting is the ability to "rapidly enter into a surge or mobilization condition in the second year [77:4]." Their support comes from the fact that most of the material for a three year buy would be on hand at the end of the 24th month. Hughes along with many other companies in the industry have noted that lead times for many parts and components have increased significantly since the mid 1970's (90:1578). A primary reason for this

was found to be inadequate capacity and very limited sources for specialty items. Both reasons can be addressed by the stability offered by multi-year pro[illegible] + would be naive to believe that industrial bas[illegible]h as the ones just mentioned could be solved by MYP [illegible] however, General Slay in testimony before the H[illegible] C[illegible]ee on Armed Services stated that he would put multi-year procurement on the top of the list of solution ideas (90:663).

Another advantage closely related to the industrial base and supplies of materials, parts, and components is inflation avoidance. This is a cost factor which has been discussed previously, but because of the unique market position of defense suppliers, further comment is appropriate. In the past the military had constituted a substantial portion of the markets for high and medium technology supplies and equipment. This is no longer true. Military electronic component procurement, for example, now represents only about 7% of the semiconductor market place (77:4). Aircraft engines and components have also seen significant increases in commercial demand [illegible]:1566-1589). Lead times for aircraft engines has gone from 19 months to 41 months in three years. The price increase for the engines was 28% for the period 1979-1980. This increase seems minimal when compared to the price increase of molybdenum which was 267% or the price increase of sleevings which was 203%. Because of low quantity demands, erratic requirements, and special

quality control and testing procedures, the industry needs the added buying power of multi-year procurement. Additionally, the Hughes Company has found that more and more of its suppliers are demanding that prices be established at delivery (77:4). Advanced purchases of these specialty items through a multi-year agreement can save a significant amount of money above that of normal inflation avoidance.

Another advantage of MYP and specifically, multi-year funding, was highlighted by the GAO in a report to Congress entitled Multiyear Authorizations for Research and Development (12). Although specifically addressing authorizations for research and development, the report stresses an important point with respect to national acquisition policy and strategy: "The complexities of modern mission requirements and weapons technologies require an indepth analysis involving national priorities, increased congressional and executive branch interaction, and more stable funding. Multi-year funding allows more time to accomplish the indepth analysis and provides for stable funding. Additionally, the longer term funding may aid in eliminating marginal low benefit programs because of more indepth mission analysis and fiercer competition for greater long-term funds. Also the analysis of the multi-year proposal will undoubtedly involve a comparison of multi-year and single-year options (28:4). This exercise should point out the high cost of flexibility afforded by annual funding.

A final advantage worth mentioning is the reduced load to the procuring agencies which results from fewer contract executions and more stable requirements. The obvious benefits are enhanced planning, cost estimating, and controlling capabilities that the procuring agency would enjoy as a result of the reduced annual contracting burden. Through these benefits, responsibility centers can effectively utilize their respective resource management systems, thereby contributing truly meaningful imputs to the Planning-Programming-Budgeting System (PPBS)[3] and the Five Year Defense Program (FYDP) (39:56-68). Cost estimates produced for the FYDP should be better and more comprehensive because of the increased time and efficiency provided to the responsibility center. These improved cost estimates should aid in controlling the cost growth of weapons systems and provide enhanced credibility to the acquisition community.

The preceeding discussion of advantages and the cost analysis provided in Chapter III tend to portray MYP as a revolutionary new strategy that can only improve the acquisition system. This is not necessarily the case. It is extremely important to point out that there are also disadvantages associated with MYP.

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[3]There are also some problems associated with the lead times required by the PPBS. These will be discussed in the context of disadvantages.

Disadvantages

Chapter II's discussion on the congressional viewpoint highlighted the primary disadvantage of MYP. With an increase in multi-year commitments comes an associated decrease in flexibility. This argument gains increased importance when the controllable portion of the federal budget is examined. The controllable portion of the budget is that amount in any fiscal year which is not mandated under existing law or not obligated by contract (71:69). The portion of the 1981 budget which was termed "relatively controllable" was $150.3 billion (70:599). Of this amount, 37.9% was for defense acquisition[4]. This fact significantly influences national decision makers and their willingness to commit even more funds to future contracts and subsequently lower future control over the budget. This reticence toward long term commitments does not exist just in congress. The Executive Branch also desires flexibility in order to accomodate national priorities, changing threats, and fiscal constraints. A recent memorandum on improving the acquisition process from the Deputy Secretary of Defense noted these disadvantages and provided some guidelines for screening potential multi-year candidates (28:3). These guidelines will be discussed later as selection criteria are developed. It is significant to note, however, that the current Deputy Secretary of Defense does not consider this

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[4]RDT&E and Procurement ($57 billion).

disadvantage as overriding and that "the economies and efficiencies of multi-year contracts shall be balanced against risks from unstable operational. technical, design, or quantity requirements [28:1]."

Another concern about the loss of flexibility was voiced by the current Deputy for Acquisition, Office of the Assistant Secretary of the Air Force, when he noted that a multi-year commitment could force decisions to enhance hardware already in production rather than to develop new alternatives to emerging threats (45:13). This is an important observation because such decisions could cause the DOD to forego revolutionary technology because of the multi-year commitment.

Probably the most obvious disadvantage to MYP is the government's liability in case of cancellation. These liabilities, as in the case of the Navy shipbuilding claims of the early 1970's, could be quite large and the payment of these charges may not lead to receipt of any additional units. Obviously, the congressional limit of $5 million on cancellation charges was an attempt to avoid this problem. Although the problem of cancellation is a real concern, evidence to support fears of excessive cancellation does not appear to exist. During the period 1976-1980, 1097 multi-year contracts were issued[5] and only 33 have been cancelled for a

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[5]These contracts were mostly Firm Fixed Price (FFP) contracts for less expensive items as compared to weapon systems.

3% cancellation rate (47:18,21).

There is also a potential for higher than optimal prices because of incorrectly set cancellation ceilings. If the ceiling does not include all allowable costs, the contractor may include a contingency amount in the price to cover the risk of cancellation (57:37). This need for contingency planning goes beyond the risks of the contractor. For the government, MYP presents the problem of quantity or technical changes. A partial program year order is not permitted by the "Cancellation of Items" and "Limitation of Price and Contractor Obligation" clauses of the contract (54:8). What this means is that the contractor should be entitled to reprice the quantity completely. This is equally true for changes. The result of these price changes could be higher costs than those that may have been obtained with a single-year contract. Of course, these contingencies can be accounted for in the initial multi-year contract; however, they may negate any cost savings possible through MYP. It is important to note that stable design and firm quantity requirements are two criteria most often cited as critical to the success of a multi-year buy. More will be said when appropriate criteria are discussed.

Another disadvantage related to the funding of a MYP concerns the amount of up-front money for recurring costs that is required to realize maximum savings. Large up-front funding could reduce already limited funds to smaller but important

programs. Conversely, if a borde-line program was procured through a multi-year buy, more important emerging programs might suffer from insufficient funding. Theoretically, these problems should not occur with proper planning and screening of candidate programs. This leads to another disadvantage.

With long term commitments which may involve large sums of money and national priorities, arises the need for higher level decision making and increased centralization. This is contrary to the current DOD Resource Management System which attempts to decentralize management and focus resource control at the responsibility center level (39:57-58). Never-the-less, current DOD policy for implementation of MYP is moving toward centralized decisions by requiring ". . . case-by-case approval by appropriately designated departmental officials [29:4]." Because the PPBS begins inputing program requirements nearly 24 months prior to congressional appropriations, contractural data including multi-year and single-year costs estimates must be made far in advance of the actual contract negotiation and, in some cases, five to seven years before completion of the contract. With the upper level review on a case-by-case basis, realistic budget programming at the responsibility center level is virtually impossible. Furthermore, because the PPBS is designed for flexibility with three options (minimal, current, and enhanced), there is the possibility of change in program quantities which

will render all MYP cost estimates[6] invalid. These considerations are, of course, not insurmountable but they do point to the need for an established procedure to separately identify and program multi-year programs.

A disadvantage which relates directly to weapon system procurement is the leverage that a sole-source[7] contractor may attain through a multi-year contract. This type of contract is noncompetitive and is specifically addressed in the Defense Acquisition Regulation (DAR). The DAR requires the contracting activity to determine that any changes which may affect price are not expected to occur and that "the item is expected to be obtainable only from a sole-source during the entire multi-year period [22:1-322.1(c)(2)]." This concern seems justified because, once a multi-year contract has been awarded to a sole-source and changes are required, two problems may arise. The first problem involves the price adjustment resulting from a change which, because of the nature of multi-year contracts, may be ". . .beyond the scope of the contract [54:10]" and an order which ". . . cannot validly be issued [54:10]." The implication seems clear--the contractor has significant leverage in renegotiating the contract price[8].

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[6]Recall that most MYP contracts are firm-fixed-price contracts based on an established quantity.

[7]Most weapon systems are procured through sole-source contracts (80).

[8]The DAR provides for modified requirements type contract based on a Best Estimated Quantity (BEQ) and maximum quantity. See Section 3-122.8 for provisions and limitations (22).

The second problem involves the early procurement of materials such as parts, assemblies, and components, which possibly may be made obsolete by the change. Although these are recurring costs which are not currently included in the allowable cancellation charge, recent initiatives point toward their inclusion in the future. Here again the implication is clear--the obsolete materials will be paid for either in a renegotiated price or, should the program be cancelled, in the cancellation charge. In either case the Government will be paying for something that may not be usable[9].

Closely related to sole source considerations is the loss of competition for several years after the multi-year contract is awarded. Though initial competition may have been enhanced, there will be little chance for further competition during the period covered by the contract. This "head start" by one contractor may preclude any competition for follow-on multi-year contracts unless a significant change in quantity or technology occurs. The result may be even a smaller industrial base in a highly specialized area if potential producers leave that area because of several years of exclusion. This disadvantage is highly theoretical with little existing evidence to support or refute it; however, it seems very

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[9]Many tools and materials would be usable, however, and could be sold or reallocated. An example is provided by the B-1 program termination which actually cost the Government only 10% of the original cancellation estimates (81:Tab A).

plausible that such concerns will arise and that careful consideration of the competitive base issue will be required during the multi-year program screening and selection process.

Another potential disadvantage of MYP was noted by the GAO and cited in Chapter I of this research paper. The most efficient rate of production for a component may be much higher than for the weapon systems into which the component is to be installed. This mismatch of production rates may result in the need for expanded storage capacity and possible periodic maintenance, both of which could contribute to additional costs. Again, good program selection and management will be required to minimize the adverse effect of problems such as these.

A disadvantage which concerns industry first but which may ultimately affect government funding is the cost of capital--the capital needed to improve production efficiencies and finance advance material purchases. With the cost of capital (interest rates) in the 12-20% range (75:2), contractors are unwilling and unable to finance these cost saving measures. As specifically referenced in Chapter II, several industries are strongly advocating 100% progress payments to cover these increased costs. Funding of outyear recurring costs is in direct conflict with the full funding policy of DODD 7200.4--a directive which still enjoys strong support of many government leaders (60).

Finally, the Defense Acquisition Regulation (and its

requirements) constitutes the basis for several considerations which may be termed disadvantages. First, the DAR requires ". . . that the unit price of each item in the multi-year requirement shall be the same for all program years included therein [22:1-322.2(a)(4),1-322.2(b)(2)]." This requirement places the burden of amortizing the recurring costs of the contract on the contractor. In nearly all cases, the costs per unit associated with the first year of production are much higher than the price. A simple graphical illustration follows:

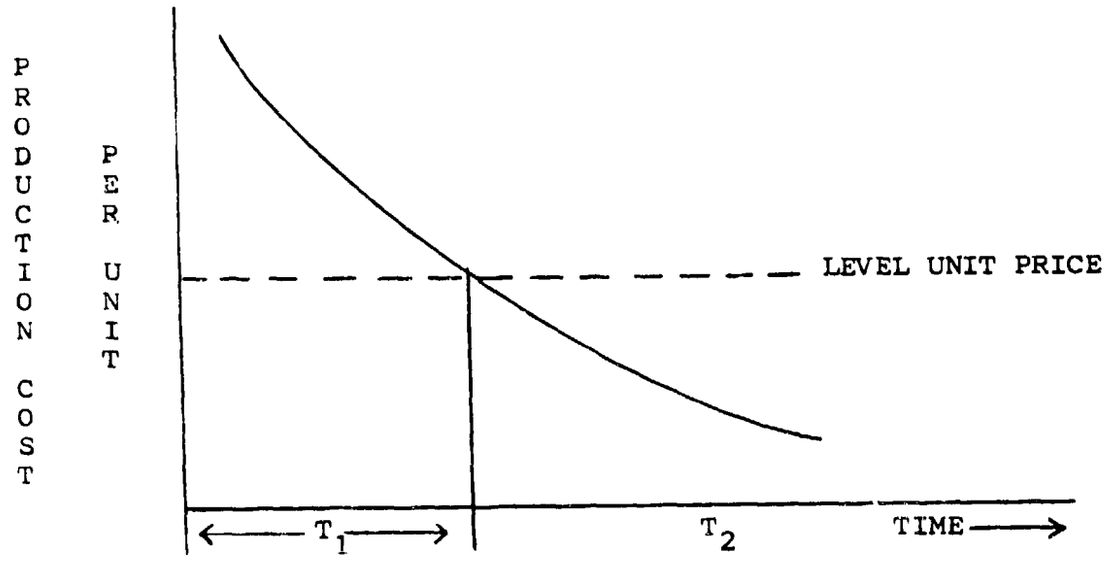

Figure 7. Relationship of Production Costs, Unit Price, and Contract Duration.

The cost of capital in the 12-20% range encountered in T_1 prohibits many contractors from participating in the multi-year buy. While it is evident that variable year-by-year

unit prices[10] would benefit industry, the practice could also pose problems for the government. In one study, government officials voiced support of level pricing because they saw problems in evaluating options (57:78-79). Additionally, the study revealed the possibility that contractors may bid an extremely high price in the first year and extremely low prices in the remaining years, thus gaining additional use of government funds while also putting the government in a position where it could not afford to cancel the contract because of the high first year costs. Another study took the opposite view citing the success enjoyed by the Air Force in its variable-priced multi-year procurement of the Lockheed C-141A aircraft (5:53). Again there is little evidence to support or refute these views. The choice should probably be left to the contracting agency where careful evaluation is possible.

The second disadvantage pertaining to the DAR involves changes to the cancellation ceiling and inclusion of recurring costs; however, it concerns a more basic problem--that of change itself. The cancellation ceiling considerations are being studied now, however, the more fundamental resistance to change will require continued effort from industry and government alike. The disadvantage is that if the changes

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[10]Variable prices would also eliminate a substantial portion of the government's cancellation liability, leaving only recurring charges (if the law and regulation permit inclusion) to be included.

are implemented and managed incorrectly, minimal acceptance and marginal employment of the concepts could negate any benefits that may be possible and, in the extreme, damage an already beleaguered acquisition process[11].

How to avoid damage to the acquisition process and at the same time capitalize on the advantages is the subject of the next section.

Multi-Year Procurement Selection Criteria

Currently, most weapon system acquisition programs are excluded as candidates for MYP because of the $5 million cancellation ceiling and the full funding policy. Major weapon system programs are becoming more and more expensive, but they also offer the greatest potential for savings through correctly applied MYP. The important point to focus on is "correctly applied." From the previous analysis, it should be clear that the intent is to maximize benefits while minimizing risks. MYP provides for increased benefits but it also includes risks. The reduction of these risks is the purpose of selection criteria.

As a departure point, the Defense Acquisition Regulation provides some rather general criteria (22:1-322.1):

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[11]The problems encountered with the Total Package Procurement (TPP) concept used to acquire the C-5A transport demonstrate the vulnerability of new concepts to change and uncertainty (65:68-71).

1. Such a contract will serve the best interest of the government by encouraging effective competition or promoting economies in performance and operation.

2. The government need for the supplies or services being acquired over the period of the contract is reasonably firm and continuing.

The DAR also implies that the contract quantities should be reflected in the DOD Five-Year Defense Program.

The first criteria is really a requirement that the benefits of MYP exist for the program, and that they are in the best interest of the government. Two considerations for this criteria concern commercial availability of the product and contractor capabilities. The commercial availability consideration reflects the idea that if the product is commercially available and the government demand does not constitute a substantial portion of the market, a multi-year buy may not save much money and may actually cost more in the case of falling prices. An example of this situation is the current price trends in computer products. There are some exceptions such as in the case of special spare parts or other logistics support requirements. The second consideration, contractor capability, refers to the economies of operation associated with long term production. If there is some doubt that the contractor can realize improved cost, schedule, and performance, a multi-year contract should not be awarded.

The second DAR criteria is part of a requirement which is universally supported by all concerned--stability.

For a program to be classified as stable, it should have a well established design and configuration on which emerging technology is not expected to have an effect; the mission for which the weapon system program is designed is not expected to change; the program should be non-controversial and have DOD support as reflected in the Five-Year Defense Program. Additionally, the program should have several years of planned production. The Hughes Aircraft Company has recommended, in addition to those mentioned, that operational test and evaluation and low-rate initial production be completed and that full-rate production should have been implemented (75:2). This Hughes approach agrees with the opinion of Brigadier General Harbour of the AFSC Aeronautical Systems Division (46). General Harbour states that MYP should not be considered until virtually all unknowns have been eliminated and the program has progressed into production. He specifically viewed the Secretary of Defense Decision Milestone III (DSARC III) as being too early for accurate appraisal.

The question of "what is stable?" has led proponents of MYP to list criteria which are actually various specifics involved in stability. As an example, Dr. Perry presented the following four criteria, all of which are indications of stability (90:1407):

1. The configuration should be established.
2. The inventory quantity known.
3. The program should be noncontroversial in need

and mission, and

4. The requirements included in the Five-Year Defense Program.

As another example, the current "Policy Memorandum on Multi-year Procurement" presents six criteria, of which four (2,3,4,5) are direct measures of stability (29: Encl 2):

1. Benefit to the government.
2. Stability of requirement.
3. Stability of funding.
4. Stable configuration.
5. Degree of cost confidence.
6. Degree of confidence in contractor capability.

The first criteria, as in the DAR, is a requirement that the government derive some benefit from the additional risk of the multi-year contract. This is a broad requirement since a lot can be included under the term "benefit." All the advantages previously listed could be termed benefits. The sixth criteria is a risk factor but it is also a sign of the program stability. This tendency to breakdown stability into important elements is evidently an attempt to clarify the subject and to provide specific criteria for weapon system multi-year selection. The fact that the criteria are more specific than those in the DAR reflects the current conservative thinking. This conservative approach is most likely due to the risks involved in procuring highly expensive weapon systems on a multi-year basis. Figure 8, which is an expanded portion

of Figure 5 of Chapter I, displays the portion of the acquisition life cycle which would be subject to MYP consideration. The applicable portion is the range where technical uncertainty and risk are relatively low and the benefit potential is high.

For the present, because MYP is relatively untried for weapon systems, the conservative criteria described above seem prudent and combined with the previous MYP analysis form the basis for the criteria developed in this research. The following is a list of appropriate MYP selection criteria:

1. The use of MYP should benefit the government. This benefit is not restricted to cost considerations but includes other issues such as standardization and industrial base enhancement.

2. The design and configuration are stable. Significant changes which could affect price through performance changes or material obsolescence are not anticipated.

3. The requirement is firm. The need and mission are well established and noncontroversial; and the quantity required is known and firm.

4. The degree of cost confidence is high. All cost elements have been examined and anticipated savings are validated.

5. Confidence in the contractor's capabilities is high. Capability of the contractor should be established through competition, market position, and past history.

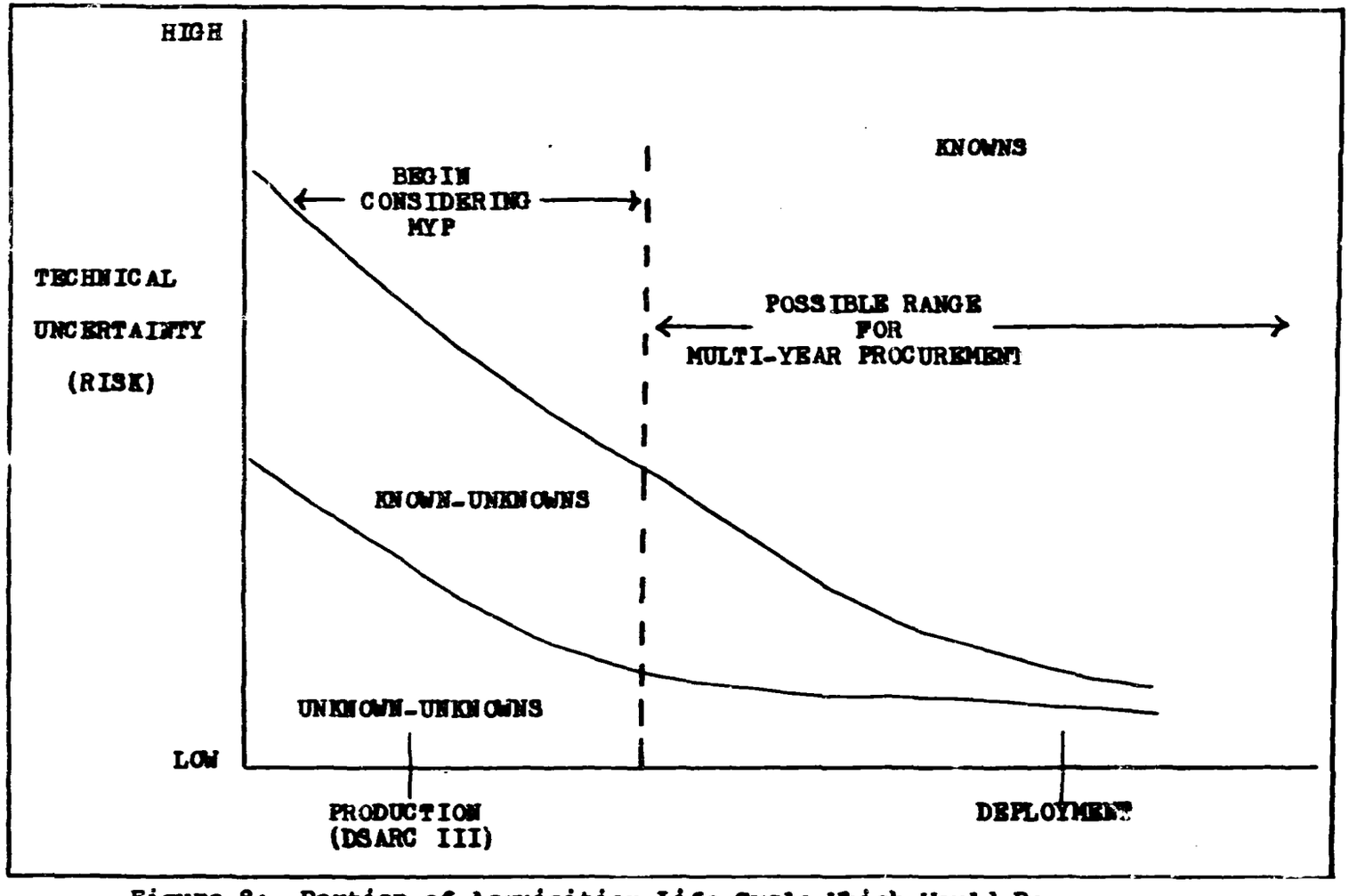


Figure 8: Portion of Acquisition Life Cycle Which Would Be Subject to MYP Consideration.

6. Program funding is stable and expected to be consistent. Funding changes are not expected to affect quantity or cause program stretch-out.

7. The requirement constitutes a substantial portion of the commercial market for which additional production and/or special repair part support would be required. Anticipated cost savings are verified.

8. MYP will enhance competition (if desired and feasible).

These criteria provide a vehicle for MYP program selection which should promote significant benefits at minimum risks. Maximum benefits may be attainable through increased risks which are associated with longer and expanded contracts. The above criteria will be used to develop the MYP decision model.

MYP Decision Model

The initial point for the model is the identification of need for the weapon system. Once the need is identified, the analysis proceeds along one of two paths depending on whether the system is currently available or must be developed.

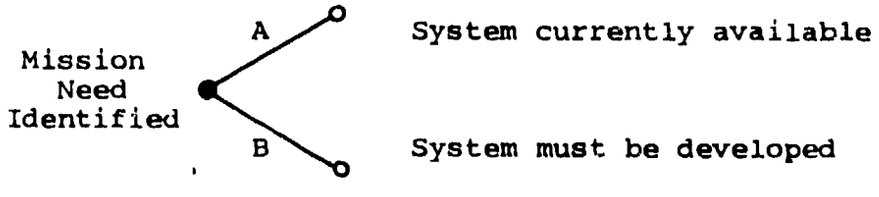
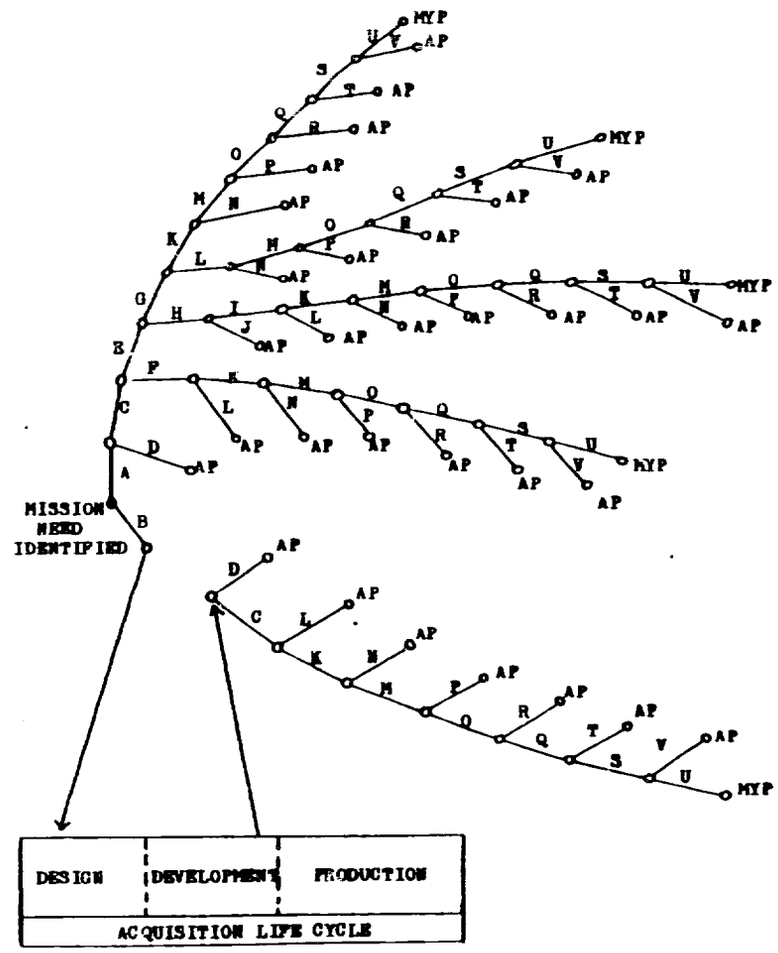


Figure 9. Initial Decision Tree Branches.

It is recognized that even if the system is currently available, there will most likely be special requirements which must be included. The extent to which the complexity and uncertainty of these special requirements impact the entire program will influence the choice of paths.

Assuming that the overall system is considered currently available, the remainder of the branch continues by considering each criteria and forming additional branches where necessary. When all applicable criteria have been considered, the model terminates at either an annual or a multi-year procurement decision.

If, on the other hand, the overall system is not available and must be developed, the model branches to the beginning of the acquisition life cycle and begins consideration of appropriate criteria near the start of production. (See Figure 8). Figure 10 displays the entire model. The criteria are considered in their logical sequence of consideration. For example, if the MYP would not promote desired competition, the next logical question would be: Would the MYP benefit the government? This question is answered by evaluating the benefits associated with design and configuration stability, firmness of requirement, contractor capability, and cost confidence. If the answer is "yes", MYP is recommended; if the answer is "no", the branch ends at the conclusion that annual procurement (AP) is recommended. Note, also, that on the branch where the requirement would constitute a small



A. System currently available

B. System must be developed

C. Program funding will remain stable

D. Funding stability questionable

E. Available on commercial market

F. Not available on commercial market

G. Requirement would constitute a substantial portion of the total market demand

H. Requirement would constitute a small portion of the total market demand

I. System will require repair part support

J. No repair part support required

K. Promotes competition, or competition is not required

L. Does not promote desired competition

M. Design and configuration are stable

N. Changes to design, configuration, or performance are anticipated

O. Requirement firm for duration of contract

P. Requirement may vary or be cancelled

Q. Contractor capable--high degree of confidence that he can deliver at estimated cost

R. Contractor capability in question

S. Degree of cost confidence high

T. Cost estimates uncertain

U. MYP will benefit the government

V. MYP has no benefit for government

MYP--Multi-year procurement
AP--Annual procurement

Figure 10: Procurement Method Decision Model.

portion of the total market demand (H), options I or J are available. These are unique options because of DAR provisions which allow MYP in specific cases where special support requirements are anticipated (22:1-322.1(c)(3)).

Summary

This chapter has presented a comprehensive discussion of the advantages, disadvantages, and recommended criteria that have become evident during this research. The model which graphically displays the criteria in a logical order for decision making is intended to concisely illustrate the prominent considerations involved in the procurement decision. The implications of the model and other considerations are the subject of the next chapter.

CHAPTER V

MODEL USE BY DECISION MAKER

The model developed in Chapter IV is the result of an analysis of many of the factors involved in the acquisition process and their impact on program outcomes. There are some important considerations which influence the use of the model in the decision process. These considerations involve the total cost impact of the decision, an analysis of the benefits and risks associated with the decision, and a priority analysis of alternate decisions. The following sections will briefly discuss these considerations.

Total Cost Impact

It should be quite evident from the foregoing chapters that a particularly important reason for the use of multi-year concepts is the possibility of reducing costs. Cost considerations are included in the benefit to the government criteria of the model; however, they are the underlying reason for most of the other criteria. For this reason, a thorough analysis of the projected costs of the program is required for both the annual procurement option and the MYP option. If there proves to be a significant amount of uncertainty in the cost estimates, a multi-year buy is not

recommended because anticipated savings of the MYP cannot be substantially validated. Without this validated benefit, the risks of a multi-year contract are not offset sufficiently to balance the benefit/risk equation[1]. An important point to remember in the cost analysis is the concept of relevant costs. A relevant cost for a decision is an expected future cost which will differ under various alternatives (48:338). An irrelevant cost is a cost which cannot be changed by current decisions. Examples are historical costs and, in some cases, fixed costs. When evaluating alternatives such as annual or multi-year procurement, special care should be exercised so as not to influence decisions by irrelevant costs. In general, comparing total program costs for each alternative will provide a better analysis upon which to base a decision. Comparing unit costs can lead to erroneous assumptions because (1) irrelevant cost may be included in the unit cost and (2) comparisons of unit costs may not be computed on the same basis. Suppose, for example, that a contractor states that with a multi-year contract (3 years) he can produce 150 aircraft per year at a unit price of $15 million; however, with an annual contract he can produce only 100 aircraft per year at a unit price of $14 million for the first year. At

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[1]The benefit/risk balance will be discussed later and is mentioned here in order to establish the importance of the cost analysis in the decision process.

first glance, the $14 million figure looks good; however, an analysis of estimated future costs indicates that the price of the annual contracts will rise at about 20% per year. For a total buy of 450 aircraft the multi-year contract would cost $6.75 billion. The total cost of the annually procured program would be approximately $8.97 billion. Additionally, the fixed costs of production may or may not be relevant. If the unit price for the multi-year buy includes an additional fixed cost for production rate improvement investments, the fixed costs are relevant. However, if the fixed costs for the contractor are the same for each type of procurement, they are irrelevant during the initial three years because they will be included in the price regardless of the type of contract. The fixed costs become relevant for the annual buy strategy during the remaining year and a half because they will be additional costs for the program which will be incurred because of the decision to contract annually.

This brief discussion of total cost impact has been an attempt to point out that in order to properly assess the impact of procuring on an annual or multi-year basis, the analyst should consider the total cost of each alternative. This approach should make the comparison of benefits and risks more valid.

Benefit/Risk Analysis

The determination of the benefits derived from pursuing a specific strategy depends, as it does for advantages and disadvantages, on the specific frame of reference from which the analyst views the outcomes. As required by the model, the multi-year strategy should benefit the government. Obviously, lower program costs would benefit the government; however, there are benefits other than cost which should be considered. The enhancement of standardization as well as the maintenance of a strong industrial base are benefits which may be even more important than cost considerations. Other possible benefits are increased competition, enhanced value engineering, and improved cost analysis and cost control. The quantification of the benefits, other than validated cost savings, is difficult and requires judgement. Because judgement is so often subjective, it is important that the decision maker objectively weigh the benefits to determine their true value to the government. The current DOD policy of case-by-case consideration of MYP candidates seems prudent in light of the wide range of values that could be assigned to a specific benefit.

The risks associated with MYP generally concern increased liability and cost, diminished requirements and funding flexibility, and reduced control of DOD programs by the Congress and the Executive branch. In order to take advantage

of the benefits, the flexibility and control risks will have to be accepted. The cost and liability risks are more controllable and are the object of the selection criteria. If the stability of funding, quantity requirements, design, configuration, and performance is questionable, the risks of higher costs than those expected through annual procurement are probably too high. Figure 11 depicts the impact of change on the procurement options. In the annual option, only a single year's material requirements are purchased, production is designed and set up for production of a yearly quantity, and all items for that annual contract are produced in that year. Alternatively, for the multi-year option, many of the multi-year material requirements are purchased in advance, production is designed and set up for optimum production of the entire multi-year quantity (of specific design), and production may not result in any end items in the first year. A change in design or configuration between years one and two could be adjusted for with annual procurement; whereas, with multi-year procurement, the entire production program would possibly require extensive change. A change at this point may render obsolete some of the materials (particularly, work in process) which were purchased in advance and could require expensive adjustments to the production line. Also, any end items already produced may need rework to align them with the new design or configuration.

Confidence in both cost estimates and the contractor

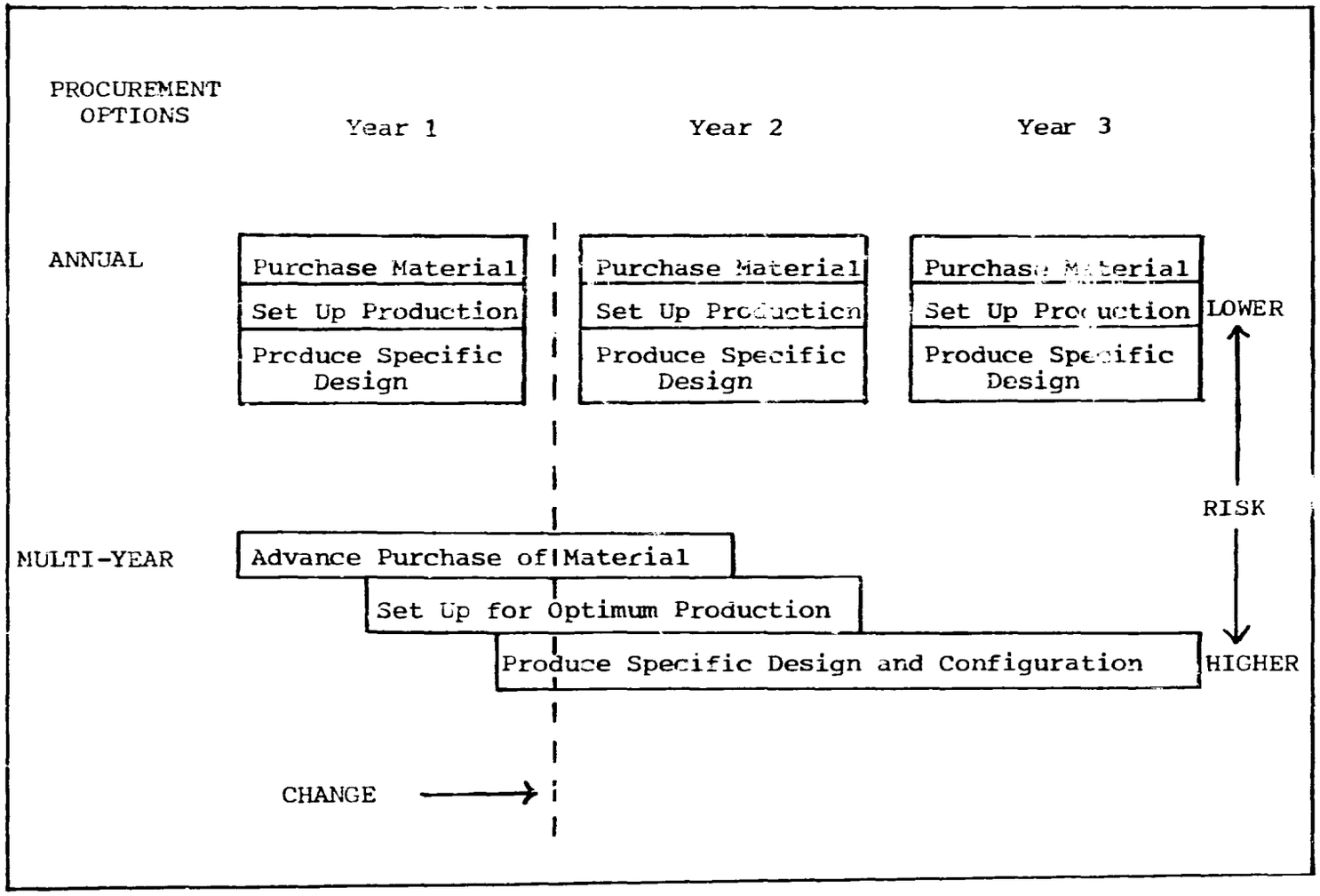

Figure 11. Impact of Change on Procurement Options.

is important. If the cost estimates are questionable because of technical uncertainty, an annual procurement strategy would be more appropriate because it would allow for developing additional data before committing to a longer term multiyear contract. Figure 12 (reproduced from Chapter I) illustrates the interdependence of uncertainty, cost confidence, and adequate data.

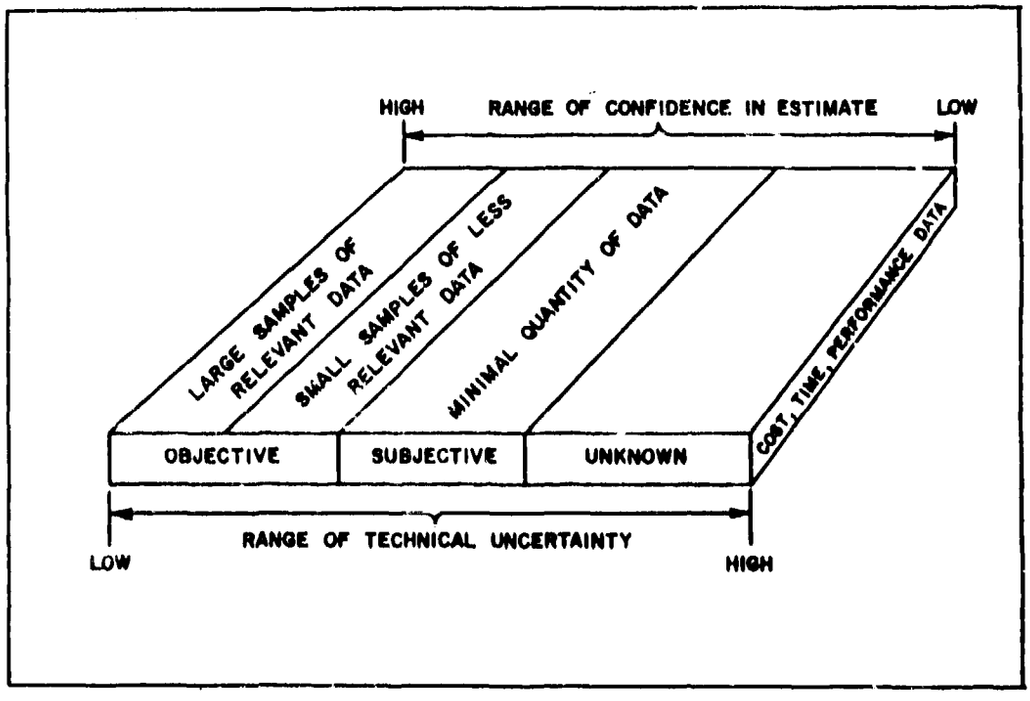

Figure 12: Spectrum of Uncertainty and Cost Confidence (42:104).

Consideration of this interdependence is crucial in estimating costs and committing to specific costs, schedules, and performance. A good benefit/risk assessment requires the objective appraisal of all the available information concerning both benefit and risk. Once this objective appraisal is

completed the criteria can be applied and the decision made. The importance of subjective inputs to the decision process is the subject of the next section.

Priority Analysis

Priority analysis is the subjective ranking of specific alternatives in order of importance. With respect to multi-year procurement, priority analysis is operative at two distinct levels. The first is the program vs. program level and the second is the benefit vs. benefit level within each program.

The program vs. program analysis concerns itself with the amount of resources that will be committed to the multi-year program as opposed to other programs. Because resources will always be limited, the commitment of additional resources to one program in the form of increased up-front funding will result in decreased resources to other programs or possibly elimination of some programs. Funding shifts to earlier years will be required to realize the benefits offered by MYP. A priority analysis of program commitments with regard to threat assessment and mission requirements will be required of each service (Army, Air Force, Navy) when selecting programs for multi-year contracts. Ultimately, Congress will perform a similar analysis from a somewhat different perspective. The important point to remember is that this subjective analysis should occur only after the objective

application of the selection criteria has been accomplished.

The second level, the benefit vs. benefit analysis, applies more directly to the model and the application of the criteria to the program. In some cases the criteria may be mutually exclusive wherein the application of one set of criteria will automatically eliminate another desired criteria. Suppose, for example, that a prime contractor has been highly successful in the research and development phases of a program and has demonstrated excellence throughout development. The System Program Office has received Secretary of Defense approval for production and is interested in a follow-on multi-year contract after initial production. Additionally, congressional interest in the program has required that enhanced competition be fostered through a dual source contracting system[2]. The problem lies in the establishment of capability of the second source and the appropriateness of the multi-year contract. The subjective decision will involve determining whether it is more important to foster competition or to realize maximum savings through a sole-source multi-year contract. The problem may be lessened by multi-year contracting with the initial development contractor and annual contracting with the second source until cost

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[2]A dual source contracting system provides for technology transfer from the development contract to the DOD which transfers the technical data to an other contractor for second source production. It has been effectively used to reduce costs through competitive forces (7:12).

confidence is high. In cases where cost confidence is high enough that it is a lesser concern than a buy-in, the multi-year contract could be used to enhance competition and preclude a buy-in. There may also be some cases where the absence of one or more of the criteria would be outweighed by the benefits or savings provided by other considerations.

Priority analysis using subjective ranking can provide the management link between national interests and program direction or, at the program level, it can provide a procurement decision based on program realities, requirements, and desired outcomes.

Sample Model Application

The F-16 fighter aircraft procurement program provides an excellent case for application of the model. The mission need for the aircraft was identified during the Vietnam War and Research and Development initiated in the mid 1970's.

Beginning at the point on the model (Figure 10, p. 105) where mission need is identified, it is clear that the desired system was not available and that the system needed to be designed and developed (94:208). This is model path B. Initial deliveries were made in 1979 and by 1981 production had reached a rate of 15 aircraft per month. Because the F-16 fighter has multi-national interest[3] and strong U.S. government support

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[3] Letters of Offer and Acceptance totalling $2.8 billion have been signed for the purchase of 348 F-16 aircraft by European Governments (94:491).

the F-16 System Program Office (SPO) began considering the production program for multi-year procurement in early 1980 after 250 aircraft had been produced. The SPO's rationale was that, with significant U.S. and European Government interest in the program, stable funding in the form of multi-year authorizations were possible (8:27). This is model path C. Because of the sole source nature of the procurement, competition was not required. This is model path K. A total assessment of the program requirements and direction by the SPO and the Air Force Systems Command determined that the design and configuration[4] were stable and that the current requirement for the final 783 aircraft was firm (82:Atch 1). This assessment follows model paths M and O. Additionally, the contractor, General Dynamics, has demonstrated its capability to deliver within cost, schedule, and performance criteria. Furthermore, the degree of confidence in the contractor's cost estimates and projected savings is high because of an indepth study performed by General Dynamics in support of MYP. This leads through model paths Q and S. Finally, the cost savings through MYP are significant as illustrated by Table 7. These cost savings are a definite benefit to the government which constitutes model path U and terminates the model at the point where MYP is recommended.

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[4]Configuration changes are planned beginning at aircraft 785; however, these changes will be included in the multi-year contract at the outset (82:Atch 1).

TABLE 7

F-16
Funding Requirements
(TY $ in Millions)*

Fiscal Year	Current Budget Forecast Eight/Month	Multi-year Funding Ten/Month	Delta
82	$1,087	$1,263	$(176)
83	1,359	1,394	(35)
84	1,313	1,391	(78)
85	1,340	1,377	(37)
86	1,338	1,410	(72)
87	1,369	1,231	138
88	1,315	589	726
89	1,154	-	1,154
90	263	-	263
	$10,538	$8,655	$1,883

*Dollar figures include airframe and support equipment and exclude engines and spares (82:Atch 1).

The total cost analysis and benefit/risk analysis were implicit in the criteria evaluation as the model progressed through each path; however, the priority analysis either was elementary (eliminating the requirement for competition, for example) or remains to be accomplished. The priority analysis which remains to be accomplished involves, for example, the determination of whether to contract for a production rate of 8, 10, or 15 per month. The production rates in excess of 8 per month would require additional early funding which may deprive other programs.

The progression through the model for the F-16 fighter program was rather simple but it illustrates the fact that MYP selection should be easy for a program that satisfies all of the appropriate criteria. This fact was an objective in the

development of the model.

Development Philosophy

There remains little to be said concerning the criteria incorporated in the model. The model is intended to present a simple conceptual approach to evaluating a procurement program and arriving at a decision concerning appropriate use of multi-year procurement. Particular criteria which do not apply should be by-passed, and if evaluation of the applicability of a certain criterion is difficult, more data (information) is probably required.

It is important to note, also, that no model or criteria will replace good judgement. The model, criteria, and good judgement should be used as integral parts of the decision process.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Modern weapon systems which are increasing in complexity are also escalating in cost and are requiring more and more time to develop and produce. Costs and schedules for new systems are experiencing dramatic growth which has been due only partly to increased complexity. Escalating cost and lengthened schedules are also in many cases the result of current government procurement practices. In particular, annual procurement has been identified as a primary cause of both an inefficient defense industrial base and costly acquisition program instability. Recent initiatives by both industry and the Department of Defense have advocated more economic procurement practices. A primary thrust of these initiatives has been toward liberalized use of multi-year procurement (MYP). In nearly all instances, members of the defense industry endorse MYP concepts because of potential cost savings and enhanced stability. The Department of Defense has also recognized the benefit potential of MYP and has issued guidelines for case-by-case implementation. Additionally, the General Accounting Office has, in several reports to Congress, recommended increased use of multi-year concepts.

The position of Congress is less enthusiastic; however, because of evidence of a failing Defense industrial base and rapidly rising costs, Congress is in the process of liberalizing the use of MYP.

There are several benefits to MYP which can be summarized as follows:

1. MYP can save money through quantity purchases, production efficiency, and inflation avoidance.

2. MYP can increase competition thereby expanding technology and enhancing the Defense industrial base.

3. MYP can improve standardization and value engineering.

4. MYP can provide for enhanced planning, budgeting, and mission/program analysis.

There are also some disadvantages or risks which can be summarized as follows:

1. MYP reduces flexibility by locking in funds.

2. MYP increases risks associated with the cost of cancellation or program change.

3. MYP may require larger up-front funding.

4. MYP implementation may require increased decision making centralization.

5. MYP may, in some cases, reduce competition by eliminating annual follow-on contracts.

6. MYP may, if misapplied, cause production costs to increase.

7. For MYP to be effective, it requires changes to legislation, policy, and regulation.

Finally, multi-year procurement must be implemented correctly. This requires that a thorough analysis of

individual program realities be accomplished and that selection criteria be used to screen candidate programs for appropriate use of MYP. Appropriate criteria have been developed as a consequence of this research and have been incorporated into a decision model for MYP selection. This model provides a conceptual basis which, when combined with the facts presented herein, should be helpful in applying the concept of multi-year procurement to weapon systems acquisition.

Recommendations

This research has presented a review and theoretical analysis of the impact of MYP on weapon systems acquisition. There remains much to be done to verify that multi-year contracts have provided net benefits in the past and that MYP can do the same in the future. To facilitate this, the following recommendations for future research are tendered:

1. An indepth analysis of previous multi-year contracts should be made to identify the historical behavior of the cost elements involved. Researchers should compare, where possible, single-year and multi-year contract cost trends through statistical analysis to determine the extent to which costs were controllable for each type of contract.

2. Research should be performed to ascertain for decision makers the factors which can be used to determine whether a program is stable enough to benefit from MYP.

Furthermore, methods by which decision making for MYP can be decentralized should be developed. Specific attention should be given to the System Program Office level.

3. The Planning, Programming, Budgeting System (PPBS) should be examined to determine how to integrate the special requirements of MYP with the long lead and flexible budgeting requirements of the PPBS. A possible approach would be to develop a method for early identification of MYP candidates including initial production estimates and early budget inputs.

4. Although the risks assessed in this paper were from the perspective of the government, there is a need to ascertain to what degree contractors are willing to assume the risks involved. Personnel who are familiar with procurement contracting should develop innovative ideas for structuring contracts for optimum multi-year benefits and reduced risks for both Government and industry. An extensive survey of Government officials and the Defense industry and a statistical analysis of the responses could provide valuable guidance in this area.

5. Optimum advantages through MYP will require legislative and regulatory changes. A thorough study of the impact of possible changes should be performed to provide an objective analysis of the possible benefits and risks.

APPENDIX

DEFINITIONS

DEFINITIONS

Advance Procurement	Procurement of material and components in advance of the fiscal year in which the end item will be procured. Currently, advanced procurement is only authorized for long lead-time components.
Annual Funding	Limiting congressional authorizations and appropriations to one fiscal year at a time.
Block Buy	The purchase of more than one year's requirement with annual contract funds.
Buy-in	The practice by a contractor of bidding low on a contract in order to win award, and subsequently recover initial year losses through follow-on contracts.
Cancellation	Applies solely to multi-year contracts and is not synonomous with termination. It is the right of the Government to discontinue a multi-year contract at the end of a fiscal year and for all subsequent fiscal years.
Cancellation Ceiling	The maximum amount that the Government will pay the contractor for nonrecurring costs (and a reasonable profit thereon) which the contractor would have recovered through the unit price, had the multi-year contract been completed.
Expenditure Funding	Ordering a specific requirement quantity at the beginning of a multi-year contract and funding contractor obligations on a yearly basis.

Full Funding	Funds are available at the time of contract award to cover the total estimated cost to deliver a given quantity of complete, militarily usable end items.
Incremental Funding	Funds are not available at time of contract award to cover the total estimated cost to complete delivery in a finished and militarily usable form.
Level Unit Price	In a multi-year contract, the first unit produced carries the same price as the last unit produced.
Multi-year Contract	A contract utilizing multi-year procurement procedures. Currently limited by the Defense Acquisition Regulation (DAR).
Multi-year Funding	Congressional authorizations and appropriations which cover more than one fiscal year.
Multi-year Procurement (MYP)	A generic term which describes procedures for acquiring needed items over several years through one contract. The intent is to lower costs through economies of scale.
Nonrecurring Costs	Production costs which are incurred on a one time basis and amortized over the period of the multi-year contract.
Recurring Costs	Production costs which enter into the product such as material and labor.
Termination for Convenience	Applies to any contract, including multi-year contracts. It is the right of the Government to discontinue, at any time, portions of or all of the contract.
Termination Liability	The maximum cost to the Government should the contract be terminated.

Termination Liabiltiy Funding	Obligating sufficient contract funds to cover the contractor's expenditures plus termination liability but not the total cost of the completed end items.

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BIOGRAPHICAL SKETCH

Jonathan Lee Brearey was born September 3, 1946 in Quantico, Virginia. After graduating from Swansboro High School in Swansboro, North Carolina, he attended East Carolina University where he earned a Bachelor of Science degree with a major in Physics and a minor in Mathematics. Upon graduation he was commissioned as a Second Lieutenant in the U.S. Air Force and assigned to pursue additional education in Meteorology at the University of Texas in Austin.

Major Brearey served five years as a Meteorologist, performing duties as an Analyst, Forecaster, and Reconnaissance Weather Officer, before being selected to attend pilot training at Webb AFB, Texas. He subsequently served in the Military Airlift Command (MAC), McGuire AFB, New Jersey, as an Airlift Operations Officer and Standardization Pilot. In 1980, he was assigned to the Air Force Institute of Technology at Wright-Patterson Air Force Base, Ohio to obtain a Master of Science degree in Systems Management.

Major Brearey's next assignment will be with the Aeronautical Systems Division (ASD) at Wright-Patterson AFB.

Major Brearey and his wife Nancy are the parents of two children, Paul and Shannan.