

Control of Major Changes to and Resultant Cost Growth in Weapon Systems Acquisition Contracts



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REPRINT

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Growth in Weapon Systems Acquisition Contracts

By

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CHAPTER I
INTRODUCTION

The purpose of this chapter is to introduce the report. The subject of the study will be presented, followed by an explanation of the purpose and significance of the research. Next, the points of view of the Congress, the Department of Defense, the defense industry and the taxpayer will be provided. The objectives of the research will be explained and the research questions presented. The scope and limitations of the study will be reviewed and some special terms will be defined. Finally, the organization of the report will be presented.

The subject is control of major changes to weapon system acquisition contracts. Control in this context means the exercise of restraining or directing influence. The term "major changes" basically means changes of high dollar value which affect the capability and/or delivery date of a particular weapon system. "Acquisition contracts" refer to contracts covering production of weapon systems for service use, rather than for research, development or testing.

The purpose of the research has been to acquire primary data concerning the causes of major changes to weapon system production contracts, to investigate what

positive actions have been taken by the government and contractors to control the occurrence of major changes and to discover new and original ideas, concepts and approaches for better controlling these changes.

The significance of the research is that it had never been performed previously. A review of the literature shows that a number of studies have been completed by the Department of Defense and the General Accounting Office into the root causes of the major changes in weapon system production contracts. Major academic efforts by Richard Lorette and James Reece have developed primary data on the relationship of changes to the effectiveness of the project manager and the relationship of changes to loss of program cost control. It appears, however, that primary data have never been developed on the prime causes of major changes nor have data been developed that could be used to develop a methodology for controlling the occurrence of major changes.

The problem of major changes and cost growth in weapon system acquisition is far reaching. From a Congressional point of view, the dollar growth was not approved nor were funds appropriated. The billion dollars plus each year that have to be provided for cost growth must come either from money earmarked for other weapon systems or from socially-oriented programs. Within the Department of Defense, major changes and cost growth could lead to discontinuance of programs important to the national defense, or to reduction in the size and/or scope of present or

proposed programs. For the defense industry, major changes and related cost growth have jeopardized major productive efforts and, in the case of companies like Lockheed and Grumman, have severely shaken the financial structure of the company. For the taxpayer, cost growth, if funded, means either increased national debt, higher taxes, or a rearrangement of national priorities so as to transfer money from socially-oriented programs to defense-oriented programs.

The objectives of the research were fourfold. The first objective was to acquire data on the causes of major changes. This was accomplished by asking the parties involved in major changes. In the past the Department of Defense has asked itself questions and placed too much trust in the answers obtained. It was significant to also get the opinions of the defense contractors. The second objective was to acquire new and original ideas for resolving or reducing the occurrence of major changes. Considering that major changes involve about a billion dollars a year, a 1% reduction would be worth \$10 million. The third objective was to make an intelligent comparison of the opinions of the principals involved in major change. The fourth objective of the research was to rekindle interest concerning major changes within the Department of Defense. Too many people both in government and industry feel that changes are a built-in aspect of weapon system acquisition. This fact may be true, but the question is

whether major changes need to be a multi-billion dollar aspect of the weapon system acquisition process.

The major research question posed was: "What recognizable variables induce major changes to weapon system acquisition contracts, and how can these variables and the resultant cost growth be more effectively controlled?" The subsidiary questions were: (1) What constitutes a "major" change to weapon system acquisition contracts? (2) What are the objectives of the Department of Defense Configuration Management Program, especially as the program relates to change control? (3) What efforts have been made by the Department of Defense within the last three years to control changes to major weapon system contracts? (4) What efforts have been made by defense industry within the last three years to control changes in major weapon system contracts? (5) In major changes to weapon system contracts, what is the relationship of informal (constructive) changes to formal changes? (6) In the view of defense contractors, what recognizable variables induce major changes to weapon system contracts? (7) In the view of government project/program managers, what recognizable variables induce major changes to weapon system contracts? (8) In the view of government procuring contracting officers and administrative contracting officers, what recognizable variables induce major changes to weapon system contracts? (9) What new and/or unusual efforts might be attempted by the government and the defense industry to control the occurrence of major changes to weapon system production contracts?

Together, these questions represented a structured attempt to elicit new information about the occurrence of major change from the principals involved in those changes.

The scope of the research for this report was limited to the investigation of major changes for those weapon systems that are in a production phase and have a program value of over \$300 million. As mentioned earlier, efforts were made to acquire information from the four principals involved in major change: the government project manager, the contractor's project manager, the government procuring contracting officer and the government administrative contracting officer. Because of the politically explosive nature of cost growth, the interview and questionnaire processes used to acquire data were conducted under a condition of anonymity. Finally, only unclassified government information was utilized in this study.

Because the language of acquisition is sometimes confusing, the following terms are defined for the convenience of the reader.

Administrative Contracting Officer - any person who, either by virtue of his position or by appointment, has authority to enter into and administer government contracts. In weapon system acquisition, the person performing the function is usually located in or near the prime contractor's plant.

Changes Clause - standard government contract clause which provides that the contracting officer may at any time, by a written order, and without notice to the sureties, make changes within the general scope of the contract in any one or more of the following: (1) drawings, design or specifications, (2) methods of shipment or packing, and (3) place of delivery.

Change Order - a written order signed by a contracting officer to make changes in the contract which are authorized by the changes clause, but without the consent of the contractor.

Configuration Management - a discipline applying technical and administrative direction and surveillance to: (1) identify and document the function and physical characteristics of a configuration item, (2) **control change** to those characteristics, and (3) record and report change processing and implementation status.

Constructive Change - any conduct by a government representative which is not a formal change order but which has the effect of requiring the contractor to perform work different from that prescribed by the original terms of the contract.

Contract Added Support Change - a change in contract requirements to reflect support items such as spare parts, training, warranty provisions, etc., which were contemplated initially but not ordered nor priced in the contract initially.

Contract Modification - any written alteration in the specification, delivery point, rate of delivery, contract period, price, quantity, or other contract provisions of an existing contract, whether accomplished by unilateral action in accordance with a contract provision or by mutual action of the parties of the contract.

Cost Growth - the difference between the final cost of the contract and the initial negotiated cost. It includes the cost of authorized contract modifications for changes plus overrun costs.

Cost Overrun - the difference between the final cost of the contract and a total of the initial negotiated cost plus the cost of negotiated contract modifications. It is the result of poor initial estimates and excessive costs.

Economic Change - a change due to the operation of one or more factors of the economy.

Engineering Change - a change in configuration identification directed by the government which does not change approved performance requirements.

Major Change - a change in which there is a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or a change which causes six months or more slippage/stretchout in delivery date.

Procuring Contracting Officer - any person who, either by virtue of his position or by appointment, has authority to enter into and administer government contracts.

In weapon system acquisition, the person performing this function is usually located in the project office or in the procurement organization supporting a particular project or projects.

Quantity Change - a change in quantity to be procured at the original price after making appropriate and consistent adjustments for cost quantity relationships.

Schedule Change - a change in approved delivery schedule, completion date or intermediate milestone of development or production.

Systems Performance Change - a change in the system performance requirement (i.e. speed, weight, reaction time, safety factors, payload and range).

Unpredictable Change - a change caused by acts of God, work strikes and changes to federal or state laws.

This report is organized in the following manner. Chapter II presents background through a review of the literature, by providing a scope of the problem, and by reviewing prior efforts made to control the occurrence of major changes.

Research methodology will be explained in Chapter III. This explanation includes discussion of the research approach, formulation of interview and questionnaire questions, test of the questionnaire, formulation of a sample design, distribution of the questionnaire, explanation of the interview technique utilized, discussion concerning analysis of data obtained and comments concerning limitations of the methodology.

The role of configuration management will be considered in Chapter IV. The chapter will include a description of the Department of Defense Configuration Management Program, an explanation of how change control operates and a review of past change control problems.

The unusual role of constructive changes will be reviewed in Chapter V. The nature and types of constructive changes will be presented and an analysis will be made of previous efforts utilized to control the occurrence of constructive changes.

Chapters VI through VIII will present the opinions of the principals involved in major changes. Their views of the definition and root causes of major changes will be presented and compared. Past efforts made by the government and contractors to control changes will be studied, and new and original ideas for controlling the occurrence of major changes will be presented.

Chapter IX will summarize the report, present conclusions and provide suggestions for further research.

CHAPTER II

BACKGROUND

This chapter presents background on the problem of changes to weapon system acquisition contracts. A review of the literature will be completed, including both academic and governmental research and reports. Next, the scope of the problem will be reviewed, with special emphasis given to the number and dollar value of contract changes. Finally, some of the prior government efforts to control contract changes will be studied.

Review of the literature shows that very little has been written about changes to weapon acquisition contracts. A few dissertations and theses covered parts of the overall problem, and other academic and governmental reports generally covered cost growth, with some attention directed to the relationship of changes to cost growth. This part of the chapter will present studies that have touched on the subject in the last ten years, with special attention given to research conducted within the last three years.

One of the first comprehensive studies of the weapon system acquisition process was performed by Merton J. Peck and Frederic M. Scherer in 1962 at the Harvard Business School. They compiled detailed case histories of twelve weapon system developments and took a detailed look at the

nature of the weapon system acquisition process, the structure and dynamics of the weapons industry and the execution of the weapons programs.¹

While their work covered all aspects of the weapon system acquisition process, they reported the relationships between cost growth and other factors such as technology advance and program priority. In addition, they reported on the work done by Marshall and Meckling relative to the relationships of cost overrun factors to: (1) the importance of minimizing cost, (2) the state-of-the-art exploitation, and (3) the importance of minimizing time.² As shown in Table 1, the mean production cost factors for weapon systems with large technological advance were twice as high as those with medium or small technical advance. They concluded that government buying agencies were less effective in controlling program costs, even when they wanted to do so, than they were in controlling schedule and quality outcomes.

Regarding causes of cost growth, they concluded that the most significant causes were unexpected difficulties due to "pure" technical uncertainties, competitive optimism in original contractor estimates, and the lack of urgency

¹Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis (Boston, Mass.: Division of Research, Graduate School of Business, Harvard University, 1962), pp. 1-594.

²Ibid., p. 432.

TABLE 1

PRODUCTION COST FACTORS, CLASSIFIED ACCORDING TO
DEGREE OF TECHNOLOGICAL ADVANCE

<u>Small Advance</u>		<u>Medium Advance</u>		<u>Large Advance</u>	
<u>Weapon Factor</u> <u>Type*</u>		<u>Weapon Factor</u> <u>Type*</u>		<u>Weapon Factor</u> <u>Type*</u>	
C	1.5	B	2.8	B	1.2
F	2.0	F	2.5	F	1.0
C	.8	F	2.0	F	.8
C	1.6	F	1.2	B	4.0
C	.9	F	.6	M	.8
F	1.5	M	1.1	M	6.4
				F	4.0
				M	2.7
				M	7.0
				M	6.0
Mean	1.4	Mean	1.7	Mean	3.4

* B=bomber C=cargo aircraft or tanker F=fighter M=missile

Source: A.W. Marshall and W.H. Meckling, "Predictability of Costs, Time and Success of Development" in Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis (Boston, Mass.: Graduate School of Business, Harvard University, 1962), p. 435.

which led to schedule slippages. Less important causes included contractor objectives which conflicted with the government's interests, inadequate contractor capability, inappropriate service decisions, and decisions delayed by service buying agencies.³

In 1962 the Logistics Management Institute (LMI) conducted a study for the Assistant Secretary of Defense (Installation and Logistics) on the subject of control of engineering and design changes.⁴ In this study LMI looked at changes made in nineteen weapon systems. Their study approach was to analyze the causes and extent of changes in value of definitized contracts for selected weapon systems and products to analyze procedures being followed by the military departments in the processing and evaluating of engineering changes. Some of the summary information developed by LMI is shown in Figure 1 and Tables 2 and 3. Note in Figure 1 that 20% of the change actions accounted for 80% of the dollar growth in systems cost.

The following conclusions were presented in the LMI study: (1) deficiencies in work statements can cause significant change actions. Cause of work statement problems are a fragmentation of technical development effort, errors and/or

³Ibid., p. 460.

⁴CHANGE MANAGEMENT: Control of Engineering and Design Changes (Washington, D.C.: Logistics Management Institute, 1963), p. 2.

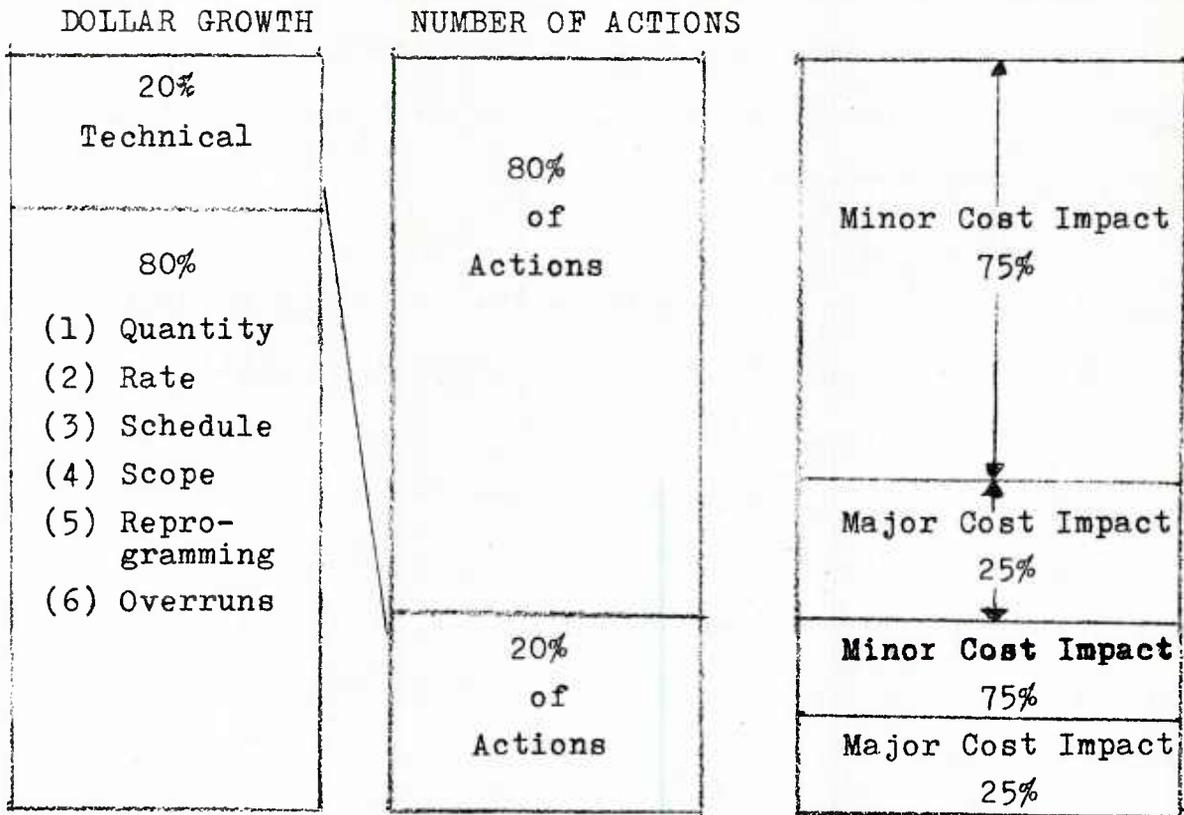


Fig.1. - - Volume of Change Actions

Source: CHANGE MANAGEMENT, Control of Engineering and Design Change (Washington, D.C.: Logistics Management Institute, 1963), p. 12.

TABLE 2
VOLUME OF CHANGE ACTIONS

Product	Number of Contracts	Number of Change Actions
F-4 Aircraft	7	450 (ECP)
PERSHING	2	10,000 (EO)
MINUTEMAN	14	1,200 (ECP)
32 Ships	32	Approximately 300 per Ship (CO)
M-60 Tanks	5	1,550 - 1st Year 811 - 2nd Year 815 - 3rd Year <u>331</u> - 4th Year 3,507 (EO)
Combat Vehicles	3	1,500 - 1st Year 600 - 2nd Year (EO)
B-58 Aircraft	5	2,500 (ECP)
465-L SAC	Letter Contracts	Considerable
C-141 Aircraft	1	44 (ECP)
Crysler Commercial Autos		9,000 per Year (EO)

Source: CHANGE MANAGEMENT, Control of Engineering and Design Changes (Washington, D.C.: Logistic Management Institute, 1963), p. 13.

TABLE 3

APPARENT ORIGIN OF CHANGES
(NUMBER OF CHANGE ACTIONS)

PRODUCT/SYSTEM	FORMAL PAPER INITIATED BY:		DESIGN CAPABILITY
	GOVERNMENT	CONTRACTOR	
DDG Class of Ships	88%	12%	BUSHIPS
32 Ships	88%	12%	BUSHIPS
465-L (SAC)	80%	20%	Contractor
F-4 Aircraft	50%	50%	BUWEPS/ Contractor
BMEWS	60%	40%	Contractor
MINUTEMAN	67%	33%	Contractor/STL
SKYBOLT	80%	20%	Contractor
PERSHING	20%	80%	Contractor and Government

Source: CHANGE MANAGEMENT, Control of Engineering and Design Change (Washington, D.C.: Logistics Management Institute, 1963), p. 14.

incompatibility in information, excessive data, understatement of work to be done, poor timing, scheduling integration and letter contracts and cost-plus-fixed-fee contracts, (2) buying-in/getting well was not considered to be a major change management problem, (3) data on contractual and program change are not readily available; data that ~~are~~ needed includes impact of changes on contractual growth, causes of such growth, effect of growth on total program estimates, effect of changes on cost reduction goals, and trends in contractual and program growth, (4) cost impact of changes is greater in concurrent situations, (5) some evidence exists that change management techniques in concurrent situations do not recognize certain critical change problems such as slow processing, retro-fit implementation, and effects on support elements, and (6) processing objectives and standards are seldom evident in change procedures.⁵

The recommendations of the 1962 LMI study covered preparation and dissemination of a unified set of change definitions and classifications. The study also recommended a single format covering the proposal and initiation of engineering changes.⁶

In 1965 McKinsey and Company prepared a report for the U.S. Air Force on changes in development and production

⁵Ibid., pp. 20-50.

⁶Ibid., pp. 64-67.

contracts. Figure 2 in an unnumbered chart from that report showing the relationship of different types of contract changes to overall cost growth.

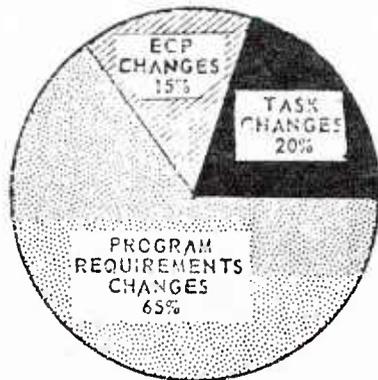
In a 1967 Harvard dissertation, Richard Lorette covered the problem of changes in his report on the relationship between pressures on the system program director and growth of weapon system cost estimates.⁷ Lorette's research approach was to query Air Force program managers through a series of questions in order to develop primary data on the relationship between pressures and growth in system cost estimates. He also referred to the 1959 Marshall and Meckling study showing the total factor increases in average cumulative cost of production for twenty-two defense programs. The factor increases reported were 1.8 for fighters, 3.4 for bombers, 1.2 for cargo and tanker aircraft and 6.4 for missiles.⁸

Lorette developed a breakdown of five different types of changes in weapon system acquisition contracts. They are: (1) changes related to quantity and schedule, (2) changes related to new capabilities or added requirements, (3) changes related to design, engineering and tests, (4) changes related to cost estimate escalation, and (5)

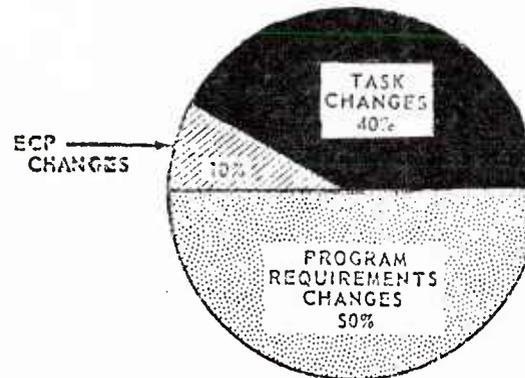
⁷Richard J. Lorette, "The Relationship Between Pressures on the System Program Director and the Growth of Weapon System Cost Estimates." Unpublished dissertation, Harvard University, 1967, pp. 1-422.

⁸Ibid., p. 1.

PROGRAM A
 (3-YEAR R & D PROGRAM -
 PROJECTED GROWTH EXCEEDS 100%)



PROGRAM B
 (1-YEAR PRODUCTION CONTRACT -
 - 20% GROWTH)



 **ECP CHANGES (HARDWARE ORIENTED)**

- "Make-play"
- Safety of flight
- Weight reduction
- Improvement (e.g., reliability)

 **TASK CHANGES**

- Technical direction from customer for
 - Tests
 - Special studies
 - Other tasks (e.g., provide data)
- Other nonhardware tasks not originally required in contract

 **PROGRAM REQUIREMENTS CHANGES**

- Scope
 - Add-on and termination of items
 - Changes in basic program definition (e.g., SOR, program requirements baseline, systems performance specifications)
- Schedule
 - Slippage due to
 - Funds availability
 - Technological breakthroughs
 - Interface delays
 - Technical failures
 - Compression due to
 - Funds availability
 - Political pressures

Fig. 2 ---- Relationship of Different Types of Changes

Source: Increasing the Effectiveness of Change Cost Management in Air Force Systems Command (Washington, D.C.: McKinsey and Company, Inc., June, 1965).

changes related to miscellaneous other causes. The miscellaneous other causes category includes such causes as invalid assumptions and/or inadvertent omissions, correction of previous estimates due to mathematical errors and unforeseen non-technical problems such as strikes and non-availability of material.⁹

In response to questions directed to Air Force program managers, Lorette received the following majority opinions: (1) Headquarters, U.S. Air Force was the major source of changes by dollar value and number for Air Force programs, (2) a contractor gets well on a buy-in by proposing changes with inflated prices, inflating the price of government proposed changes, and/or by failing to reduce the contract price by the amount of work deleted by the change, and (3) the program managers were very seldom able to negotiate a firm price for a change before a contractor was directed to commence work on the change.¹⁰

Lorette also asked the program managers for their opinion as to the causes of changes. The causes cited by the program managers were: (1) indecision as to mission concept, (2) change in requirements, including new requirements by using commands, and (3) deficiencies revealed by category I, II and III tests.¹¹

⁹Ibid., p. 18.

¹⁰Ibid., p. 342.

¹¹Ibid., p. 343.

In his conclusion, Lorette developed reasons for growth in system cost estimates. They were: (1) additional requirements, (2) schedule change, (3) low initial estimate, and (4) delayed decisions.¹² Lorette felt that the source of most weapon system acquisition changes was the government itself and the causes of these changes were change in requirements, changes in concepts and deficiencies revealed by testing. While most of Lorette's recommendations related to the pressures on the program managers, one related directly to changes in production contracts. He recommended that using commands be required to fund program changes which they initiate, a move which would force them to consider the dollar impact of requested changes.¹³

A 1968 Industrial College of the Armed Forces report on the management of the F-111 weapon system developed some early statistics on the depth of the change problem. The report stated that as of May, 1968, there were 1226 contract change notifications to the F-111 production contract, which increased the cost of the overall program by approximately \$1,787 million.¹⁴

The Chief of Naval Material in 1969 conducted a study of pricing and cost control problems in the shipbuilding

¹²Ibid., p. 367.

¹³Ibid., p. 389.

¹⁴Report on Weapon System Management - F-111.
Washington, D.C.: Industrial College of the Armed Forces,
May 31, 1968.

and conversion management system.¹⁵ Part of this study related to control of changes and specifications and the study reported five change control problems. They were: (1) continued inadequacies in ship contract plans and specifications which require correction by means of mandatory change orders, (2) specifications are sometimes issued which push the state-of-the-art or which have major cost impacts that are not anticipated, (3) changes have been initiated with inadequate knowledge of costs and uncertain plans as to how these changes will be financed, (4) many Navy organizations, through their interaction with the contractor by reason of their technical control of government furnished material and information, may cause changes to a shipbuilding contract which have neither been anticipated nor provided for, and (5) heavy reliance on government furnished plans and specifications in lieu of contractor proposed plans and specifications that are performance-oriented makes the government vulnerable to increases in costs resulting from change orders and claims.¹⁶

This same report includes eight recommendations concerning the handling of changes in shipbuilding and conversion contracts. They were: (1) ship acquisition project managers should ensure that all decisions impacting

¹⁵U.S. Department of Defense. Naval Material Command. SCN PRICING AND COST CONTROL STUDY. (Washington, D.C.: Naval Material Command, April, 1969), pp. 1-24.

¹⁶Ibid., p. 10.

upon the cost of a ship would be made within existing established financial authorization or reserves, (2) Naval Ship Systems Command (NAVSHIPS) should replace the then current Change Review Sub-Board with configuration control boards, one of which would be established and chaired by each project manager, (3) NAVSHIPS continue the Flag Officer Change Review Board with revised functions which include over-all guidance and monitorship of the individual change control boards, (4) changes affecting more than one project should be referred to the Flag Officer Change Review Board for approval, (5) all proposed changes to the project or contract or to agreed-to interfaces with systems/equipment would be treated as engineering change proposals, (6) each project manager would have the responsibility for approving or disapproving all Class I engineering change proposals, (7) NAVSHIPS develop a uniform method by which each configuration change board would develop statistics to identify the number and causes of changes, effect of approved changes in terms of cost and/or schedule delay, and the number and types of changes approved, and (8) NAVSHIPS ensure that all new contracts for ships with private shipyards or naval shipyards invoke configuration management requirements.¹⁷

The Rand Corporation performed a study of system acquisition experience for the U.S. Air Force in 1969.

¹⁷Ibid., p. 12.

The study reported the results of an analysis of twenty-one Army, Navy and Air Force system acquisition programs of the 1960's which had a cost of about \$19 billion. The approach of the study was to compare the ratios of the actual-to-predicted outcomes of programs of the 1960's to programs of the 1950's.¹⁸ Four of the report's conclusions related to the problems of major changes in weapon system production programs. They were: (1) relatively little is known about change in scope decreases or their implications, (2) not enough is known about the causes of cost escalation to support the contention that estimating errors are major contributors, (3) the data plainly suggest that the system or program contracted for often differs very substantially from the system or program actually delivered or carried out, and (4) factors outside the control of the contractor generally were held to cause most of the differences between the predicted cost of the original program and the ultimate cost of the actual program, and between the projected performance and the delivered-article performance. Very little is known about the origin, magnitude or control of such factors.¹⁹

In a study made for the Air Force in 1970, the Mathematica Corporation outlined the following three broad

¹⁸R.L. Perry, D. DeSalvo, G.R. Hall, A.J. Harmen, G.S. Levenson, G.K. Smith and J.P. Stucker. SYSTEM ACQUISITION EXPERIENCE (Santa Monica, California: The Rand Corporation, November, 1969), p. iii.

¹⁹Ibid., p. 42.

causes of cost growth in weapon system acquisition: (1) deliberate misstatement of initial program costs, (2) the inherent uncertainty associated with major state-of-the-art advances, and (3) inadequacies of planning and control.²⁰

Probably the most comprehensive study of changes to weapon system acquisition contracts was conducted by James Reece at Harvard in 1970.²¹ The subject of his dissertation was "The Effects of Contract Changes On the Control Of a Major Weapon System Program". His research approach was to conduct an in-depth study of the change process being used in the production of the F-111 aircraft by the General Dynamics Corporation in Texas. Reece began his study by showing the flow process of a contract change. This flow is shown in Figure 3. He divided contract changes into categories of configuration changes, task changes and program changes. Configuration changes were defined as those which alter the configuration of an item being built for delivery to the government. Task changes were defined as non-hardware tasks adding or altering test programs and feasibility studies. Program changes were defined as major and usually very expensive revisions to quantities, technical performance specifications, delivery schedules or rate of funding for programs.²²

²⁰Study and Control of Cost Overruns (Princeton, N.J.: Mathematica, March, 1970), p. 1.

²¹James S. Reece, "The Effects of Contract Changes On the Control of a Major Defense Weapon System Program." Unpublished DBA dissertation, Harvard University, 1970, pp. 1-8-28.

²²Ibid., p. 2-5.

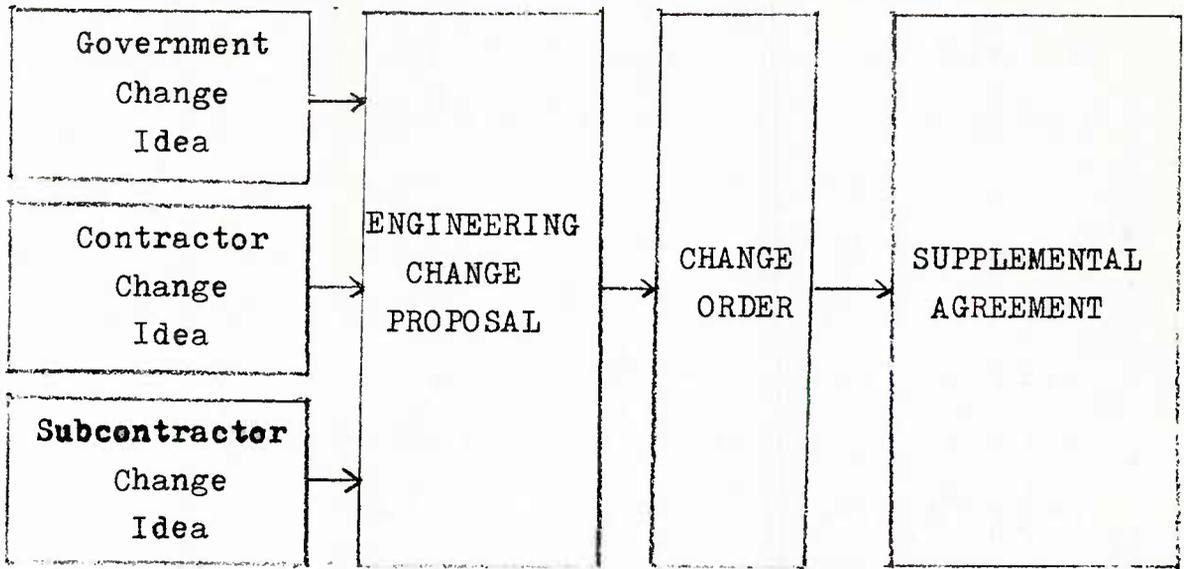


Fig. 3.----- Flow Process of a Contract Change

Source: James S. Reece, "The Effects of Contract Changes On the Control of a Major Defense Weapon System Program." Unpublished DBA dissertation, Harvard University, 1970, p. 2-4.

Reece noted that a contract change is generated when a person or group of people perceives a need for the change and is able to convince the appropriate decision makers that the apparent need is sufficiently great to warrant spending the estimated change cost to implement the change.²³

Reece also referred to an earlier McKinsey and Company study for the Air Force Systems Command which showed that 20% change growth in a normal production program was made up of 10% configuration changes, 40% task changes and 50% program changes.²⁴

With the help of the General Dynamics Corporation, Reece was able to develop empirical data on the relationship of contract changes to the basic program cost of the F-111. This relationship is shown in Table 4. Note that program and engineering changes constituted 83.5% of total cost growth.

Reece noted that the most clear-cut causes for contract changes are engineering change proposals (ECP's). The types of engineering change proposals involved are: (1) correction of deficiencies, (2) improvement changes, (3) state-of-the-art advances, (4) value engineering changes, (5) optional accessories, and (6) gold plating.²⁵ A full explanation of these type changes will be provided in Chapter IV which covers configuration management.

²³Ibid., p.2-17.

²⁴Ibid., p.2-12.

²⁵Ibid., p. 2-18 thru 2-22.

TABLE 4

RELATIONSHIP OF CONTRACT CHANGES
TO F-111 PROGRAM COST
(In Millions of Dollars)

		% of 5	% of 6
1. Basic Program	713		
2. Program Changes	423	28.6	55.3
3. Engineering Changes	216	14.6	28.2
4. Overrun	<u>126</u>	8.5	16.5
5. Total Indicated Cost	1478		
6. Total Cost Growth	765		

Source: James S. Reece, "The Effects of Contract Changes on the Control of a Major Defense Weapon System Program," Unpublished DBA dissertation, Harvard University, 1970, p. 2-13.

Reece divided the people who initiate changes into the following three groups: (1) government and contractor engineers who try to achieve engineering excellence, (2) the users who demand a reliable system and who feel that unless changes are made, new systems will be obsolete when they roll out the factory door, and (3) the contractor, who generates changes when his program is over target cost, behind schedule or not meeting technical specifications.²⁶

Reece makes an astute observation that there are no countervailing forces within the using command to restrict the improvement changes to those which are critical.

Concerning contractor buy-in, Reece presented two approaches: (1) the contractor offers lower than cost and then overprices changes, or (2) the contractor realizes that the customer does not know what he wants, so the contractor bids/proposes on a buckboard and then upgrades the buckboard to a Chevrolet with changes.²⁷

Regarding pricing of contract changes, Reece noted that the contractor has the upper hand in justifying and negotiating estimated change costs because of the large size, greater experience and lighter workloads of contractor's cost analysis staff.²⁸ In this regard he also notes that there is a tendency for the contractor to submit low

²⁶Ibid., p. 2-23.

²⁷Ibid., p. 2-32.

²⁸Ibid., p. 2-35.

preliminary cost estimates and high final cost estimates for changes. This is done because: (1) approval of the change is desired, (2) grass roots estimator in company must live with his final estimate so gray areas are estimated high, (3) tendency for high final estimates because some of the amount will be lost in the negotiation process, and (4) management may inflate the final estimate for protection purposes.²⁹

Reece found that at the F-111 plant, work was started on changes 99% of the time before negotiation began for pricing the change. Also, work was half completed 50% of the time before negotiations started, and the change work was finished 20% of the time before negotiations started.³⁰ He also found that one contract supplemental agreement covered 1173 engineering change proposals and 51 of those 1173 engineering change proposals represented 50% of the dollar value of that one supplemental agreement.³¹

Regarding the contractor accounting for changes, Reece noted that although General Dynamics had financial performance reports, their work order system was not capable of collecting actual costs on a change by change basis.³² He noted that the contractor did attempt to capture the

²⁹Ibid., p. 4-21.

³⁰Ibid., p. 4-26.

³¹Ibid., p. 4-28.

³²Ibid., p. 5-41.

actual cost of changes for a period of one year, but stopped because the employees would not charge job order numbers correctly and because actual tasks changed so much that at one point General Dynamics had over 100,000 individual job order numbers for changes.³³

Reece observed the effect of changes on the assembly line. He noted that a worker would be given one white work card which directed that a particular task be performed, and as many as five blue change cards directing changes to the work directed by the initial white card. In some cases the fourth or fifth blue change card would delete the change action directed by the first or second blue change card. This arrangement made it extremely difficult for foremen to properly crewload.³⁴

At the Air Force F-111 program office, Reece was able to summarize the results of the F-111 Configuration Control Board. These results are presented in Table 5. From the overall data, Reece took a sample of 573 production contract changes and found that 50 changes (8.7%) accounted for 90.5% of the total target cost increase and 5 changes (.9%) represented about 53.4% of the total target cost increase.³⁵

³³Ibid., p. 6-34.

³⁴Ibid., p. 6-18.

³⁵Ibid., p. 7-8.

TABLE 5

SUMMARY OF F-111 CONFIGURATION CONTROL BOARD
ACTIVITY - JANUARY 31, 1970

Type Change	# Proposed	# Approved	% Approved
Hardware (ECP's)	2844	2307	81.1
Task	288	133	58.4
Specification	1685	1335	79.2
Credit (Work Deleted)	118	74	62.7
Total Change Actions	4875	3849	79.0%
Estimated Cost	\$1092 MIL	\$ 758 MIL	69.3%

Source: James S. Reece, "The Effects of Contract Changes On the Control of a Major Defense Weapon System Program," Unpublished DBA dissertation, Harvard University, May, 1970, p.7-9.

Reece developed six major conclusions relating directly to contract changes. They are: (1) degree of contractor control over total program costs is lessened as the portion of the total program cost which represents changes to the original program increases, (2) the contractor did not control the work associated with a change as an entity, separate from the original program, (3) the contractor did not maintain records of actual costs to compare with the original estimates on a change by change basis, (4) there are no rewards or punishments clearly related to good or poor contractor change cost performance, (5) overpricing of changes may be a result of conscious management strategy, and (6) collecting change cost is extremely difficult even under a work breakdown system. It was feasible to end up with 234,373 change work packages and job orders on the F-111 aircraft.³⁶

Reece presented seven major recommendations concerning contract changes. They were: (1) focus on major changes by establishing unique accounts for the budget and actual costs of each major change, (2) develop benefits for achieving good change cost performance, (3) improve incorporation of changes into the control system, (4) eliminate budgetary discontinuities by distributing change budget through the budget ledgers in a timely fashion, (5) cut down on the number of changes, (6) make changes at pre-determined

³⁶Ibid., p. 8-26.

break points, and (7) earlier negotiation of prices on changes to force the contractor to control costs.³⁷

In 1970 Thomas Faleskie completed an MBA thesis at The George Washington University on the factors of cost overrun in the weapons acquisition process. He reported that there were four primary factors causing cost overruns. They were: (1) technology uncertainty, (2) an apparently strong contractor incentive to deliberately make a low estimate in order to buy-in on a program, (3) the optimism that pervades initial program decision making, with a resulting unrealistically low contract bid, and (4) simple economic inflation.³⁸

The Report to the President and the Secretary of Defense on the Department of Defense by the Blue Ribbon Defense Panel in July, 1970, made three recommendations relating to contract changes in major weapon system acquisition. They were: (1) that reduction of technical risks through demonstrated hardware be accomplished before full-scale development, (2) that a general rule be issued against concurrent development and production, and (3) that production decisions be deferred until successful demonstration of developmental prototypes.³⁹

³⁷ Ibid., p. 8-28.

³⁸ Thomas Joseph Faleskie. "THE FACTORS OF COST OVERRUN IN THE WEAPONS ACQUISITION PROCESS," Unpublished Masters Thesis, The George Washington University, 1970, p. 81.

³⁹ U.S. Department of Defense. Blue Ribbon Defense Panel. Report to the President and the Secretary of Defense on the Department of Defense (Fitzhugh Report), Washington: D.C.: Government Printing Office, July, 1970), p. 218.

A 1970 report issued by the Office of the Assistant Secretary of Defense (Installation and Logistics) noted that over one billion dollars every year was spent on engineering changes and modifications to equipment being produced for and used by the services.⁴⁰ The report noted that there was inadequate control of changes during production. Problems reported include: (1) changes and retrofit programs were initiated before tests determining whether they corrected a deficiency or improved equipment, (2) engineering changes requiring government approval were classified incorrectly, thereby hindering configuration control, (3) no central coordinating points for engineering change proposals were established, and manufacturers of subsystems were not always notified of the engineering change proposals, (4) requests for engineering change proposals were not coordinated within the systems program office, (5) the configuration management practices of the contractor were inadequate, (6) procedures for evaluating engineering change proposals were inadequate with respect to eliminating duplicate contract effort and cost, (7) procedures for obtaining full price reductions for deleted efforts were lacking, and (8) delays in processing engineering change proposals resulted in aircraft being produced without necessary changes and caused extensive retrofit programs.⁴¹

⁴⁰U.S. Department of Defense. Office of the Assistant Secretary of Defense (Installations and Logistics). Audit Review 71-1, (Washington, D.C.: Government Printing Office, July, 1970), p. 1.

⁴¹Ibid., p. 2.

Also in 1970 Howard Schloeman completed an MBA thesis at The George Washington University on the subject of controlling cost overruns in weapon system acquisition. He developed definitions for different types of contract changes. He defined schedule change as a change in cost estimates caused by a change in an approved delivery schedule, completion date, or intermediate milestone of development or production. Schloeman defined a system performance change as a change in cost estimates caused by a change in system performance requirements (i.e. speed, weight, reaction time, CEP, payload, range and safety factors).. An engineering change was defined as a change in cost estimate caused by a change in configuration identification which does not change approved performance requirements. Finally, Schloeman defined economic change as a change in cost estimates caused by a change due to the operation of one or more factors of the economy other than that covered by contractual price adjustments.⁴²

In 1970 Michael Heffron conducted a study for the Center for Naval Analysis concerning cost overruns in the Navy's shipbuilding program. He pointed out that there were ten major causes for the large cost overruns in Navy shipbuilding. They were: (1) inadequate planning for the early, firm definition of ships, (2) funding of developmental

⁴²Howard Lambert Schloeman. "CONTROLLING COST OVERRUNS IN WEAPON SYSTEM ACQUISITION," Unpublished MBA Thesis, The George Washington University, 1970, p. 37.

systems and experimental ships with shipbuilding funds, (3) reducing budget prices of ships below those developed by professional ship cost estimators, (4) inadequacy of specifications, control of change orders and early anticipation of claims, (5) lack of adequate management information and cost control systems for the project manager, (6) unsuccessful control of naval shipyard new construction, (7) failure to balance program decisions with their cost impacts, (8) shortages of manpower at Naval Ships Systems Command headquarters and other shipbuilding and conversion management support activities, (9) inability to forecast accurately the economic conditions in the shipbuilding industry, and (10) reprogramming of apparent excess funds to offset new program requirements.⁴³

For a number of years the General Accounting Office has been conducting studies for Congress and reporting on the acquisition of major weapon systems by the Department of Defense. In their March 18, 1971 report, the General Accounting Office presented a comprehensive analysis of cost changes for fifty-two weapon systems as of June 30, 1970.⁴⁴ This analysis is presented as Table 6.

⁴³Michael Heffron, "Heffron Report, September 1970," unpublished report for the Center for Naval Analysis, Washington, D.C.: September, 1970, p. 5.

⁴⁴U.S. Congress. Acquisition of Major Weapon Systems. Report B-163058 to the Congress of the United States by the Comptroller General. (Washington, D.C.: Government Printing Office, March 18, 1971), p. 61.

TABLE 6

Analysis of Cost Changes as of June 30, 1970

<u>Type of cost change</u>	<u>Army</u>	<u>Navy</u>	<u>Air Force</u>	<u>Total</u>
	----- (millions) -----			
Quantity change:				
Increase	\$1,371.1	\$11,105.5	\$ 122.3	\$12,598.9
Decrease	<u>-3,098.8</u>	<u>-1,760.5</u>	<u>-5,357.1</u>	<u>-10,216.4</u>
Net	<u>-1,727.7</u>	<u>9,345.0</u>	<u>-5,234.8</u>	<u>2,382.5</u>
Other changes:				
Engineering changes	489.3	463.8	3,119.4	4,072.5
Support "	155.2	-57.7	1,268.5	1,366.0
Schedule "	462.1	1,308.7	844.7	2,615.5
Economic "	550.5	1,156.0	2,307.9	4,014.4
Estimating "	1,312.8	3,356.9	1,509.5	6,179.2
Sundry "	-12.7	553.1	544.3	1,084.7
Unidentified "	-	2,264.9	-	2,264.9
Total	<u>2,957.2</u>	<u>9,045.7</u>	<u>9,594.3</u>	<u>21,597.2</u>
Total	<u>\$1,229.5</u>	<u>\$18,390.7</u>	<u>\$4,359.5</u>	<u>\$23,979.7</u>
Number of systems	12	29	11	52

Source: U.S. Congress. Acquisition of Major Weapon Systems.
 Report B-163058 to the Congress of the United States by the
 Comptroller General. Washington, D.C.: Government Printing Office,
 March 18, 1971, p. 61.

In March, 1971, the Army Procurement Research Office issued its first report relative to cost growth in weapon system acquisition.⁴⁵ This report was unique in that it developed statistical equations to distinguish between cost growth and overrun. Average cost growth was defined as final cost of the contract (C_f) minus initial negotiated cost (C_i) divided by initial negotiated cost (C_i) or $(C_f - C_i)/C_i$. Average overrun/underrun is defined as final cost of the contract (C_f) minus adjusted target cost (C_a) divided by adjusted target cost (C_a) or $(C_f - C_a)/C_a$.⁴⁶ Using these equations, the report develops summary statistics for average cost growth for an aggregate sample of 740 research, development and production contracts. This summary is presented in Table 7. By probing the accumulated data, the following conclusions were reported: (1) a significant difference was observed for total cost growth and contract modifications on production contracts between contract types and between commodity clauses, and (2) a significant difference was observed for the cost overrun component of growth on production contracts between a sample of ten individual contractors.⁴⁷

⁴⁵J. Michael Cummins, William B. William, and Shirley H. Carter. PRODUCTION COST GROWTH (Fort Lee, Virginia: Army Procurement Research Office, March, 1971), pp. 1-38.

⁴⁶Ibid., p. 8.

⁴⁷Ibid., p. 34.

TABLE 7

AVERAGE COST GROWTH AS A PERCENTAGE OF COST BY TYPE OF WORK

Classification	No. of Contracts	Average Cost Growth $\frac{C_f - C_1}{C_1}$	Average Contract Modifications $\frac{C_a - C_1}{C_1}$	Average Overrun/Underrun $\frac{C_f - C_a}{C_a}$
R&D	236	257.49 (870.31)	240.86% (868.10)	9.85% (29.91)
Production	504	108.23% (432.80)	102.85% (430.20)	3.06% (17.17)

Source: J. Michael Cummins, William B. Williams and Shirley H. Carter. PRODUCTION COST GROWTH Fort Lee, Virginia: Army Procurement Research Office, March, 1971), p. 18.

In his MBA thesis at The George Washington University on the relationship of effective cost estimating to weapon system cost growth, Don Dellis made note of an important fact regarding the effect of program decisions on weapon system unit costs. Table 8 shows the relationship of F-14 program costs to the number of aircraft to be purchased and to the number of years the program will be in production.⁴⁸

In a 1972 MBA thesis at The George Washington University, William McAdams studied the problems of contract changes in major weapon system contracts. He presented nine factors relating to weapon system procurement which were behind the extensive change action that has been observed in weapon system acquisition. They are: (1) lack of early clear definition of military requirements, (2) inadequate acquisition planning, (3) concurrency, (4) deficiencies in contractual requirement documents such as specifications and drawings, (5) defective or late government furnished material, (6) the length of the acquisition cycle combined with a rapidly advancing technology, (7) contractor problems and attitudes, (8) constructive changes, and (9) desire within the Department of Defense for the best possible product.⁴⁹

⁴⁸Donald O. Dellis. "AN ANALYSIS OF COST GROWTH AND ITS CAUSES IN MAJOR WEAPON SYSTEM ACQUISITION." Unpublished MBA Thesis, The George Washington University, 1971, p. 44.

⁴⁹William Michael McAdams. "CONTROLLING CHANGES IN MAJOR DEFENSE PROCUREMENT CONTRACTS." Unpublished MBA Thesis, The George Washington University, February, 1972, p. 41.

TABLE 8

COMPARISON CHART OF COSTS FOR
F-14 AIRCRAFT PROGRAM
(In billions of Dollars)

	313	469	722
	aircraft	aircraft	aircraft
Current Estimate	5.207	7.188	9.811
No Fiscal Year 1972 Buy	6.475	8.824	12.051
Cost Delta	+1.268	+1.636	+ 2.240

Source: U.S. Congress, Senate, Committee on Annual Services, Fiscal Year 1972 Authorization for Military Procurement, Research and Development, Construction and Real Estate Acquisition for the Safeguard, ABM and Reserve Strength, 5.934 (HR 8687), 92nd Congress, 1st. Session, 1971, p. 4116, in Donald O. Dellis, "AN ANALYSIS OF COST GROWTH AND ITS CAUSES IN MAJOR WEAPON SYSTEM ACQUISITIONS," Unpublished MBA thesis, the George Washington University, December, 1971, p. 44.

In May, 1972, the U.S. Army Procurement Research Office completed another statistically oriented report concerning cost growth in weapon system acquisition contracts. This report constituted further research in the area of production cost growth and showed the relationship of contract duration, the definitized contract dollar amount, inflation and the level of technology to overall cost growth.⁵⁰ A new predictive equation was developed, based on analysis of data from all contracts over \$1 million. This equation shows that the percentage of cost growth equals minus .265 minus .000037 times initial negotiated cost (C_i) plus 60.5 times duration. This equation could be interpreted as meaning that for each year in contract duration there is a corresponding 60.5% increase in the rate of cost growth. Also, for each million dollar increase, there is a corresponding decrease of 37% in the rate of cost growth.⁵¹

A 1972 report by the Assistant Secretary of Defense (Comptroller), covering the economics of defense spending, attempted to clarify the reasons for cost overruns. Some of the reasons listed were: (1) engineering changes, including those that do and do not affect system performance,

⁵⁰Robert L. Launer, Harold F. Caneley and Shirley H. Carter. Cost Growth - Effects of Contract Size, Duration, Inflation and Technology. (Fort Lee, Virginia: U.S. Army Procurement Office, May, 1972), pp. 1-41.

⁵¹Ibid., p. 13.

(2) support changes, including such items as spares and training equipment not included in the original estimate, (3) schedule changes, (4) economic changes relating to unforeseen purchase inflation, (5) estimating errors, (6) unpredictable changes including strikes, changes in state or federal laws or acts of God, and (7) other changes, which include pure and simple overruns. ⁵²

It is interesting to note that the Report of the Commission on Government Procurement, dated December, 1972, did not include recommendations concerning the problems of changes to major weapon system acquisition contracts..

Finally, a General Accounting Office report entitled Cost Growth in Major Weapon Systems, dated March, 1973, conducted an analysis of cost histories of forty-five weapon systems as of June 30, 1972. The report listed three major causes of cost growth. The first cause listed was inaccuracy in estimating. This cause was reported to be the result of unrealistically high performance requirements, sheer difficulty of guessing the unknowns and predicting technology and over-optimism on the part of the bidders and the buyers. The second cause listed was inflation, and the third cause was revisions to the specification, including time schedules,

⁵²U.S. Department of Defense. Office of the Assistant Secretary of Defense (Comptroller). THE ECONOMICS OF DEFENSE SPENDING - A LOOK AT THE REALITIES. (Washington, D.C.: Government Printing Office, July, 1972), p. 158.

quantities, and/or engineering changes. This last cause could have been the result of trying to do too much or trying to develop and produce the system too fast.⁵³ A representation of the relationship of these causes is provided by Figure 4.

The scope of the problem of changes in weapon system acquisition contracts is broad. Almost every system has experienced or is now experiencing major changes. Probably the clearest way to describe the scope is to use hard figures. Table 2, presented earlier, shows the number of changes being experienced as far back as 1962. The table also shows that changes are not limited to weapon system contracts.

In his 1969 dissertation, Reece showed the relationship of change orders to the fiscal year 1969 service budget for research, development, test, evaluation and production. His summary is presented in Table 9. Note that in 1969 change orders amounted to 6.8% of the total Department of Defense expenditures for research, development, test, evaluation and production of weapon systems. More specifically, Reece showed the relationship between number of changes and their dollar value for the F-111. This summary is presented in Table 10. Note that of the \$456.3 million

⁵³U.S. Congress. Cost Growth in Major Weapon Systems. Report B-163058 to the Congress of the United States by the Comptroller General. (Washington, D.C.: Government Printing Office, March 28, 1973), pp. 25-29.

ANALYSIS OF PROGRAM COST HISTORIES ON 45 WEAPON SYSTEMS

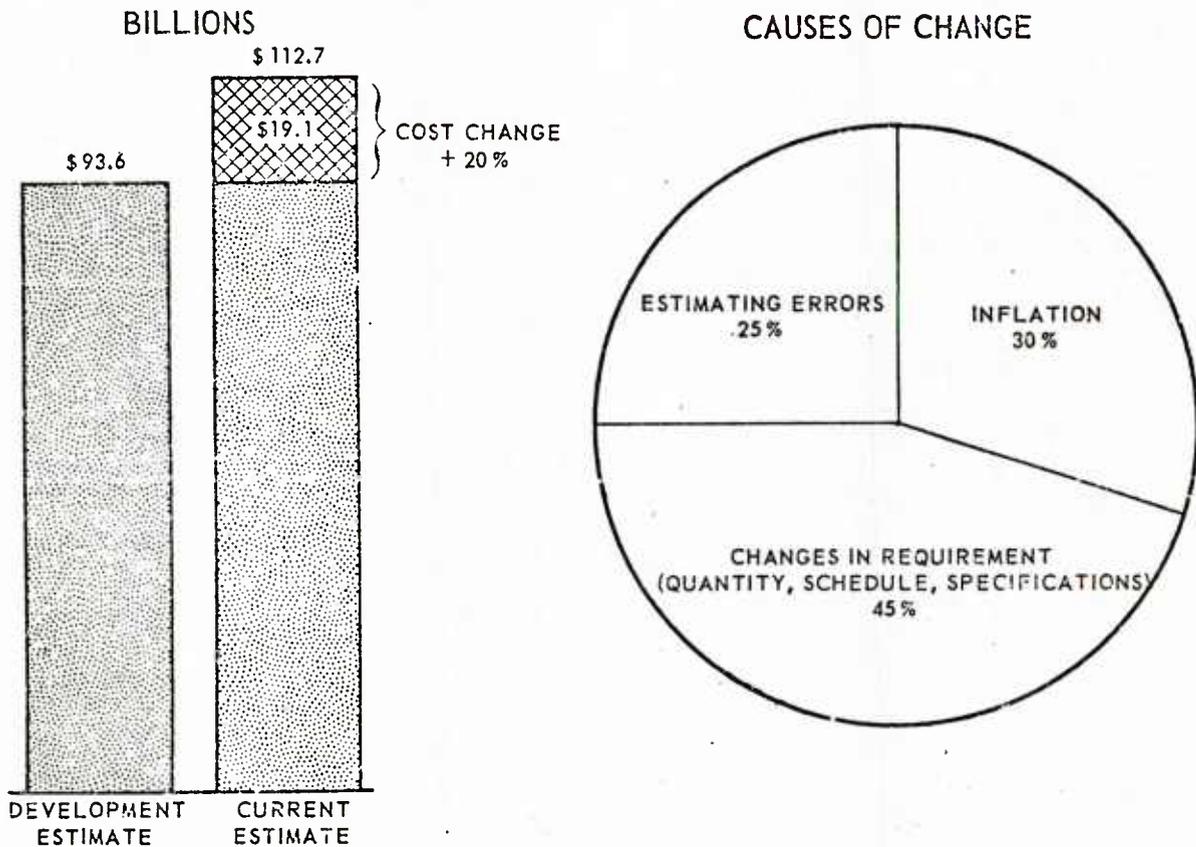


Fig. 4

Source: U.S. Congress. Cost Growth in Major Weapon Systems. Report B-163058 to the Congress of the United States by the Comptroller General. Washington, D.C.: Government Printing Office, March 26, 1973, p. 26.

TABLE 9

RELATIONSHIP OF CHANGE ORDERS TO
DOD FISCAL YEAR 1969 BUDGET
(In Millions of Dollars)

FISCAL YEAR 69	RDT&E	PROCUREMENT	SUM	CHANGE ORDERS	% CHANGE ORDERS
ARMY	1,629	6,887	8,516	183	2.1
NAVY	2,161	7,928	10,089	333	3.3
AIR FORCE	3,373	9,581	12,954	1,634	12.6
	7,647	24,455	32,102	2,166	6.8

Source: James S. Reece, "The Effects of Contract Changes On the Control of a Major Defense Weapon System Program," Unpublished D.B.A. dissertation, Harvard University, May, 1970, p. 2-9.

TABLE 10

RELATIONSHIP BETWEEN NUMBER OF PRODUCTION CHANGES
AND THEIR DOLLAR VALUE FOR F-111 AIRCRAFT

NO. OF CHANGES	% OF TOT. NUMBER	CUM. \$ SUB-TOT.	% OF TOT. DOLLARS
1	.174520069	67707	14.8375164
2	.349040139	131035	28.7154055
3	.523560209	185353	40.618816
4	.698080279	215961	47.3263455
5	.872600349	243768	53.4200555
10	1.74520069	325424	71.3143979
15	2.61780104	349831	76.6630215
200	3.49040139	365883	80.1807053
25	4.36300174	378507	82.9471668
30	5.23560209	388462	85.1287355
35	6.10820244	395823	86.7571873
40	6.98080279	462036	88.11434
45	7.85340314	407544	89.3104226
50	8.72600349	412770	90.455664
100	17.4520069	437504	95.5759475
150	26.1780104	476410	97.8276352
200	34.9040139	450952	98.8229828
250	43.6300174	453507	99.3828932
300	52.3560209	454726	99.6500285
350	61.0820244	455450	99.8086881
400	69.8080279	455888	99.9046727
450	78.5340314	456115	99.9544182
500	87.2600349	456241	99.9820302
550	95.9860383	456300	99.9949597
600	104.712041	456323	100.

NUMBER OF CHANGES: 573

AVERAGE CHANGE SIZE (\$000): 796.375

Source: James S. Reece, "The Effects of Contract Changes On the Control of a Major Defense Weapon System Program," Unpublished D.B.A. dissertation, Harvard University, May, 1970, p.707.

in changes to the F-111, ten changes (1%) amounted to \$325.4 million or 71.3% of the total change dollars.

Another view of the scope of the change problem can be seen by looking at specific kinds of problems. The Navy reported that at the end of 1971 it had an inventory of over \$1.06 billion in claims covering alleged constructive changes to weapon system contracts.⁵⁴

Probably the best source of data on the exact scope of the contract change problem is the General Accounting Office. In a July, 1972 report on the acquisition of forty major weapon systems, the General Accounting Office presented a comprehensive breakdown of change costs by service and type. This information is provided in Table 11. Note that changes during Fiscal Year 1971 amounted to about \$18.7 billion.

In a 1972 report on the economics of defense spending, the Comptroller of the Department of Defense presented a similar breakdown of change cost by type and related the breakdown to the percentage of the adjusted development estimate for forty-five weapon systems. This summary is presented in Table 12. Note that the cost increase shown of \$19.8 billion is 22.8% of the adjusted development estimate for the systems.

⁵⁴U.S. Department of Defense. U.S. Naval Material Command. Memorandum dated April 3, 1972. Enclosure 1, Chart 7.

TABLE T1

Analysis of Cost Changes in Fiscal Year 1971

<u>Type of change</u>	<u>Army</u>	<u>Navy</u>	<u>Air Force</u>	Change during fiscal year 1971
	(millions)			
Total quantity decrease--net	\$ <u>512.6</u>	\$ <u>10,460.5</u>	\$ <u>239.4</u>	\$ <u>11,212.5</u>
Other changes:				
Engineering	\$ 167.5	\$ 702.2	\$ 744.1	\$ 1,613.8
Support	167.7	445.5	516.8	1,130.0
Schedule	156.6	924.2	364.7	1,445.5
Economic	1,326.9	1,251.3	1,598.3	4,176.5
Estimating	295.8	2,887.0	2,287.1	5,469.9
Sundry	66.5	561.0	1,926.2	2,553.7
Unidentified	-	<u>2,296.4</u>	-	<u>2,296.4</u>
Total other changes	\$ <u>2,181.0</u>	\$ <u>9,067.6</u>	\$ <u>7,437.2</u>	\$ <u>18,685.8</u>
Number of sys- tems	11	24	11	46

Notes:

1. The above data represents total changes (increases and decreases), other than quantity, which occurred in fiscal year 1971 on 46 systems for which we have comparable data.
2. The above types of changes were originally adopted by GAO on advice of DOD as proper classifications of the causes or reasons for changes. After several reviews on this basis, we have concluded that, in the future, more specific analysis of changes will result in improved classifications of the basic causes.

Source: U.S. Congress. Acquisition of Major Weapon Systems. Report B-163058 to the Congress of the United States by the Comptroller General. Washington, D.C.: Government Printing Office, July 17, 1972, p. 37.

TABLE 12

RELATIONSHIP OF CONTRACT CHANGES TO
% OF ADJUSTED DEVELOPMENT ESTIMATE 1972

Type	\$ Billions	% of adjusted development estimate
Engineering Changes	\$ 4.2	4.8
Support Changes	1.2	1.4
Schedule Changes	3.5	4.0
Economic Changes	4.3	5.0
Estimating Changes	4.3	5.0
Unpredictable	.5	.6
Other	<u>1.8</u>	<u>2.1</u>
Net Increase	\$19.8	22.8%

Source: U.S. Department of Defense.. Office of the Assistant Secretary of Defense (Comptroller). THE ECONOMICS OF DEFENSE SPENDING - A LOOK AT THE REALITIES. Washington, D.C.: Government Printing Office, July, 1962, p. 157.

Another view of the scope of the change problem can be seen in looking at the change orders that are undefinitized or those for which the government and the contractor have not reached a price although the work may have been completed. Table 13 shows the undefinitized change order backlog for the Navy as of December 1, 1972. Note that \$448 million of the undefinitized change orders were over 6 months old.

From a purely statistical point of view, Table 14 shows the total number and dollar amount of contract modifications issued by the Department of Defense during Fiscal Year 1972. Considering modifications for additional work and change orders, note that 771 change orders or 10.4% of the change orders represented \$1.2 billion or 82.9% of the total change order dollars, and that 713 additional work modifications or 5% of the additional work modifications represented \$5.2 billion or 80.6% of the total additional work dollars. Change orders over a million dollars represented 69.3% of all change order dollars and additional work modifications over a million dollars represented 80.6% of all additional work dollars. The obvious point being made here is that a small percentage of large changes represent a majority of the total dollars involved.

Finally, the Office of the Directorate of Operations Information of the Office of the Assistant Secretary of Defense (Comptroller) has issued a summary report showing a distribution of cost growth by type by weapon system for

TABLE 13

UNDEFINITIZED CHANGE ORDER BACKLOG
U.S. NAVY - DECEMBER 1972

ORGANIZATION	\$ MILLION	% OF TOTAL \$
NAVAL SHIPS SYSTEMS	\$325	57
NAVAL AIR SYSTEMS	122	11
NAVAL ORDINANCE SYSTEMS	39	7
STRATEGIC SYSTEMS PROJECT	8	1
OTHER NAVY	26	5
AIR FORCE REQUIREMENTS	26	5
DEFENSE CONTRACT ADMIN. SERVICES	<u>23</u>	<u>4</u>
	\$569	100
OVER 6 MONTH OLD - \$448		

Source: U.S. Department of Defense. Chief of Naval Material. Memorandum dated December 4, 1972, TAB B.

TABLE 14
NUMBER AND DOLLAR VALUE OF
CONTRACT MODIFICATIONS - FY 72
 (AMOUNTS IN MILLIONS)

SIZE (IN DOLLARS)	M O D I F I C A T I O N S									
	SUB-TOTAL		ADDITIONAL WORK		FUNDING ACTION		CHANGE ORDER		TERMINATION	
	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT	NUMBER	AMOUNT
\$10,000,000 OR MORE	315	\$ 7,802	138	\$ 3,593	154	\$ 3,641	23	\$ 568	0	\$ 0
5,000,000 OR MORE	520	9,017	210	4,078	267	4,279	39	675	4	14
2,000,000 OR MORE	1,199	10,797	442	4,808	618	5,111	129	908	10	31
1,000,000 OR MORE	2,021	11,700	713	5,184	1,042	5,541	243	1,021	23	47
500,000 OR MORE	3,549	12,533	1,238	5,545	1,764	5,916	497	1,140	50	68
300,000 OR MORE	5,217	13,029	1,773	5,749	2,594	6,136	771	1,222	75	77
200,000 OR MORE	6,941	13,337	2,337	5,884	3,401	6,256	1,109	1,278	94	81
100,000 OR MORE	11,024	13,733	3,620	6,061	5,361	6,411	1,864	1,353	179	92
50,000 OR MORE	18,000	14,082	6,213	6,242	8,366	6,529	3,070	1,413	351	103
25,000 OR MORE	27,414	14,288	9,629	6,359	12,369	6,595	4,738	1,447	678	113
10,000 OR MORE	42,020	14,419	14,285	6,433	19,059	6,635	7,417	1,474	1,259	122
AVERAGE SIZE (DOLLARS)		\$ 343,156		\$ 450,298		\$ 348,107		\$ 198,782		\$ 96,938
CUMULATIVE PERCENT										
\$10,000,000 OR MORE	0.7%	54.1%	1.0%	55.9%	0.8%	54.9%	0.3%	38.5%	0.0%	0.0%
5,000,000 OR MORE	1.2	62.5	1.5	63.4	1.4	64.5	0.5	45.7	0.3	11.7
2,000,000 OR MORE	2.9	74.9	3.1	74.8	3.2	77.0	1.7	61.5	0.8	25.3
1,000,000 OR MORE	4.8	81.1	5.0	80.6	5.5	83.5	3.3	69.3	1.8	38.2
500,000 OR MORE	8.4	86.9	8.7	86.2	9.3	89.2	6.7	77.3	4.0	55.6
300,000 OR MORE	12.4	90.4	12.4	89.4	13.6	92.5	10.4	82.9	6.0	63.5
200,000 OR MORE	16.5	92.5	16.4	91.5	17.8	94.3	15.0	86.7	7.5	66.4
100,000 OR MORE	26.2	95.2	25.3	94.2	28.1	96.6	25.1	91.7	14.2	75.0
50,000 OR MORE	42.8	97.7	43.5	97.0	43.9	98.4	41.4	95.8	27.9	84.6
25,000 OR MORE	65.2	99.1	67.4	98.9	64.9	99.4	63.9	98.1	53.9	92.9
10,000 OR MORE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* LESS THAN 0.05 PERCENT
 PERCENTAGES BASED ON THOUSANDS OF DOLLARS.

Source: U.S. Department of Defense. Office of the Assistant Secretary of Defense (Comptroller). MILITARY PRIME CONTRACT AWARDS - SIZE DISTRIBUTION FISCAL YEAR 1972. Washington, D.C.: Government Printing Office, 1972, p. 7.

forty major systems as of December 31, 1972. This summary is presented as Table 15. Note that cost growth for these forty systems, as a result of changes other than quantity, totals \$17.3 billion. Note also that engineering schedule and economic changes are predominant.

As can be seen from this portion of the chapter, the scope of the contract change problem in weapon system acquisition is broad. It represents thousands of major contract changes worth billions of dollars. The next part of the chapter will describe prior efforts by the government to control the problem.

The presentation of prior efforts to control contract changes will be by service for purposes of clarity.

McAdams, in his 1972 MBA thesis, summarized the efforts of the Office of the Secretary of Defense to control changes. He noted that one major effort was the introduction of the prototype concept to weapon system acquisition.⁵⁵ The distinct advantages of prototyping are: (1) extensive production changes are reduced, (2) there is relief from problems of defective specifications, (3) it can be determined whether or not the proposed design of the system will meet the requirements to be placed on it, and (4) testing and evaluation can be conducted before the production phase begins.

⁵⁵McAdams, Controlling Changes, p. 77, citing David Packard, Department of Defense, Deputy Secretary of Defense, statement before the House Appropriations Committee, House of Representatives, September 16, 1971.

TABLE 15

Distribution of Cost Growth by Category (Other than Quantity Changes)
As of December 31, 1972
(\$In Millions)

Weapon System	Engineering		Support		Schedule		Economic		Estimating		Unpredictable		Cost Overrun		Contr. Perf. Incentive		Other a/		Weapon System Total		
	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	This Qtr	To Date	
ARMY																					
LANCE (Battalions)	\$+ 2	\$ 11	\$ -	\$ 15	\$ -	\$ 59	\$ -	\$ 42	\$- 5	\$ 1	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$- 3	\$ 127
Imp. M2K (Battery Sets)	+ 3	35	+ 5	87	+ 10	99	+ 2	50	- 1	33	-	-	-	1	-	-	-	-	+ 19	305	
SAFEGUARD (Sites)	-	34	-	362	-	697	-	790	- 51	170	-	-	-	-	-	-	-	-	- 51	2,053	
SAM-D (Tac. Fire Sec.)	-316	-316	+ 27	27	-	-	-	-143	+ 1	1	-	-	-	-	-	-	-	-	-431	431	
HLH (Component Dev.)	-	-	-	-	- 2	-	-	- 1	- 1	-	-	-	-	-	-	-	-	-	- 4	-	
UTIAS	-	- 25	+ 1	- 6	-	-	-	152	-	- 82	-	-	-	-	-	-	-	-	+ 1	39	
NAVY																					
A-7E	-	102	-	19	- 1	711	-	204	-	43	-19	-19	-	-	-	-	-	-	- 20	1,060	
AV-8A	+ 2	7	- 1	3	-	-	-	24	- 4	- 20	-	-	-	-	-	-	-	-	- 3	14	
E-2C	- 2	49	- 3	43	-	51	-	57	-	88	- 2	- 2	-	-	-	-	-	-	- 7	286	
NOT REPORTED																					
F-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/5	
P-3C	-	67	+ 16	-204	+ 37	209	+ 12	172	-	-	-22	-22	-	7	-	-	-	-	+ 43	1/5	
S-3A	-	- 10	+131	143	+ 89	124	-	212	- 18	- 7	-21	-21	-	1	-	-	-	-	+131	229	
AEGIS (R&D Only)	-	-	-	13	-	-	-	43	-	-	-	-	-	-	-	-	-	-	-	442	
CONDOR	-	57	-	- 7	-	29	-	81	-	71	- 2	- 2	-	-	-	-	-	-	- 2	56	
HARPOON	- 1	2	-	10	-	8	+ 1	3	-	-	-	-	-	-	-	-	-	-	-	289	
PHOENIX	-	-	- 6	26	+ 7	370	-	117	-	-	- 2	- 2	-	46	-	-	-	-	- 1	23	
POSEIDON	-	47	- 53	- 78	-	40	-	40	- 9	263	-	-	-	-	-	-	-	-	- 62	561	
SPARROW III E	-	6	-	18	-	95	-	17	-	- 11	-	-	-	-	-	-	-	-	-	312	
SPARROW III F	-	19	+ 12	22	+122	231	- 84	179	+ 30	62	- 1	36	-	-	-	-	-	-	+ 79	107	
NOT REPORTED																					
TRIDENT	-	10	- 11	68	-	-	-	1	-	140	-	-	-	-	-	-	-	-	- 11	549	
MX-48 MOD 1	-	-	+ 17	17	-	-	+144	548	-	-	-	-	-	-	-	-	-	-	+161	113	
SSN-595	-	-	-	3	- 2	+ 11	224	14	-	-	-	-	-	-	-	-	-	-	+ 11	219	
DD-363	-	-	-	-	-	-	- 2	14	-	-	-	-	-	-	-	-	-	-	- 2	565	
DLGR-38	-	-	-	-	-	-	- 2	131	-	131	-	-	-	-	-	-	-	-	- 2	221	
LHA	-	-	-	-	-	-	- 3	131	-	131	-	-	-	-	-	-	-	-	- 2	14	
CVAN-68 Class	-	92	-	7	-	-	- 2	119	-	-	-	-	56	-	-	-	-	-	- 2	262	
AM/BBQ-5	-	95	-	-	-	-	+ 13	25	-	- 7	-	-	-	-	-	-	-	-	+ 13	274	
AIR FORCE																					
A-7D	-	152	+ 13	103	-	50	-	41	- 5	- 75	-	-	-	-	-	-	-	-	+ 8	271	
A-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
B-1	-	402	-	97	-	313	-	14	-	-734	-	-	-	-	-	-	-	-	-	92	
C-5A	-	266	-	164	-	96	-	410	- 17	870	-	-	-	-	-	-	-	-	- 17	1,306	
F-5E	-	7	+ 11	15	- 3	2	-	-	+ 14	- 17	-	-	-	-	-	-	-	-	+ 22	-	
F-15	-	3	-	-101	-	-	-	-	-	- 7	+33	585	-	-	-	-	-	-	+ 33	180	
F-111A/D/E/F	-	1,457	- 4	683	-	766	-	207	- 51	1,007	-	-	-	-	-	-	-	-	- 55	4,050	
AWACS	- 93	- 92	- 87	- 81	+ 35	35	-	-	-128	-135	-	-	-	- 2	- 2	- 1	- 1	-	-276	276	
MAVERICK	-	1	- 1	7	-	14	-	48	-	- 8	-	2	-	24	-	9	-	-	- 1	97	
MINUTEMAN II	-	155	- 7	77	+ 19	34	-	-	-	- 49	-	-	-	-	-	- 1	-	386	+ 12	602	
MINUTEMAN III	+ 7	651	-	-134	+ 42	62	-	95	- 2	-238	-	89	-	-	-	5	+ 11	1,100	+ 44	1,630	
SRAM	-	176	-	119	-	-	-	42	- 11	437	-	-	- 5	71	-	3	-	-	- 16	345	
SPARROW III F	- 1	- 10	- 3	- 1	+ 12	48	+ 6	40	+ 6	28	-	-	-	-	-	-	-	-	+ 20	105	
SUMMARY																					
ARMY	-311	-261	+ 33	485	+ 8	854	-142	891	- 57	123	-	-	-	1	-	-	-	-	-469	2,004	
NAVY	- 1	543	+102	103	+254	1,866	+ 95	2,211	- 1	752	-69	- 28	-	110	-	-	-	-	+350	5,557	
AIR FORCE	-101	3,168	- 78	888	+105	1,420	+ 6	897	-194	1,079	+33	676	- 7	93	- 1	15	+ 11	1,486	-226	9,722	
GRAND TOTAL	\$-413	\$3,450	\$+ 57	\$1,476	\$+367	\$4,140	\$- 41	\$3,999	\$-252	\$1,954	\$-36	\$ 648	\$- 7	\$204	\$- 1	\$ 15	\$+ 11	\$1,486	\$-315	\$17,372	
% of Total		20		8		24		23		11		4		1		-		9		100	

a/ MM Command Data Buffer and Upgrade Silo Program.
 b/ No F-14 SAR for December 31, 1972; program being restructured.
 c/ SAR on TRIDENT does not contain a Program Cost Baseline; thus, cost growth not reported.

McAdams also made note of the change control attributes of a July, 1971 Department of Defense Directive 5000.1 concerning acquisition of major defense systems. This directive has three provisions which relate to control of contract changes. They are: (1) full scale development cannot begin until the developmental risks have been identified and solutions are in hand, (2) use of cost type contract for development, which reduces the contractor's need to get well through changes, and (3) a provision that change orders shall be contractually priced or subject to an established ceiling before authorization.⁵⁶

Finally, McAdams noted a requirement in the Department of Defense Directive 3200.9 which requires approval by the level of the Office of the Secretary of Defense for changes to a system that has a developmental cost in excess of \$25 million or would require a total production investment in excess of \$100 million.⁵⁷

In change control efforts, the Navy has concentrated on the special problems of constructive changes and unpriced change orders. The Navy's action regarding constructive changes will be described in detail in Chapter V, but it basically involves education of engineering and contracting personnel and the development and use of anti-claim contract clauses.

⁵⁶Ibid., p. 80.

⁵⁷Ibid., p. 89.

Regarding unpriced change orders, the Navy has taken two specific actions. By a January 16, 1973 memorandum, the Chief of Naval Material directed that no unpriced change orders could be issued without his personal approval. By a December 4, 1972 memorandum, he specified that by June 30, 1973, the Naval Systems Commands can have no more than 5% of their unpriced change order actions in an over six months old category. This latter action was an effort to reduce the situation shown in Table 13, where 79% of the Navy's unpriced change actions were over 6 months old.

The Air Force has tried various approaches to controlling contract changes. In their aircraft engine contracts, a clause is usually included which provides that changes will be incorporated into the contract without changing the contract price as long as the cumulative value of all the changes to date do not exceed plus or minus 1% of the contract price.⁵⁸ Also, in the contracts for the C-5A and the F-15, clauses were included that specified that on any individual change, where the estimated or negotiated target cost was \$100,000 or less, no change in target cost, target fee, target profit or ceiling price would be made.⁵⁹

The Air Force Systems Command issued an Air Force supplement to the Armed Services Procurement Regulations on November 15,

⁵⁸Ibid., p. 88.

⁵⁹Ibid., p. 89.

1972, directing that no contract changes can be issued unless a "not to exceed" price is first negotiated.

The Army has developed a positive program to control contract changes in the Program for the Refinement of the Material Acquisition Process (PROMAP-70). The program addresses five problem areas: (1) excessive optimism in cost estimating, (2) control of changes in on-going programs, (3) comprehensive assessment of risk prior to system development, (4) use of competitive prototypes in development, and (5) excessive concurrency in development, test and production.⁶⁰ One of the direct results from PROMAP-70 was the centralization of administrative processing of engineering change proposals which resulted in a reduction in the approval rate of engineering change proposals from 68% in 1969 to 62.5% in 1970.⁶¹ The Army also developed procedures for the management and control of all change orders from date of issuance to definitization. Reporting is also required for changes that exceed \$10 thousand for all acquisition contracts having an award value of \$1 million or over.⁶²

⁶⁰McAdams, Controlling Changes, p. 81, citing Department of the Army, Army Material Command, Executive Summary - Program for the Refinement of the Material Acquisition Process, January, 1971, p. 1.

⁶¹Ibid., p. 82.

⁶²Ibid., p. 83.

Chapters VI, VII and VIII will present further change control efforts made by both the government and contractors. These efforts were discovered during the current research.

In summary, this chapter has presented background on the problem of control of major changes to weapon system acquisition contracts. A review of the literature was conducted, relating important academic and governmental research efforts in this area. The dissertations of Lorette and Reece were most noteworthy. Next, the scope of the problem was analyzed, particularly from the point of view of factual statistics. It was concluded that contractual changes were a multi-billion dollar problem. Finally, prior efforts to control contract changes were reviewed. The policy of the Office of the Secretary of Defense on prototyping, Navy constructive change and unpriced change order control efforts, Air Force contractual features, and the Army PROMAP-70 programs appeared particularly noteworthy.

CHAPTER III

RESEARCH METHODOLOGY

This chapter presents the research methodology used to acquire data for the report, including the research approach, formulation of interview questions, development of the questionnaire, sample design, distribution of the questionnaire, interview technique, analysis of data and limitations of research methodology.

A search of the literature showed that very little had previously been written concerning the causes of major changes in weapon system production contracts. The research approach was to develop empirical data by querying the principals involved in approving, directing, accepting and performing the major changes. In looking carefully at the defense weapon system acquisition process, it was determined that these principals were the government project manager, the contractor's project manager, and the government procuring and administrative contracting officers.

Since the thrust of the research was toward major changes, it was decided to query change principals associated with large systems for which summary financial information was published in the quarterly Department of Defense Selected Acquisition Reports. Systems in these reports are those of over \$300 million in value. The Selected

Acquisition Reports for December 31, 1972, showed that there were twenty-five large systems in production stage.

It was initially decided that interviews would be conducted with the change principals involved with four systems selected from each service. Interview questions were formulated to develop answers to the research and subsidiary questions. The interview questions covered subjects such as causes of major changes, problems with constructive changes, the functioning of the DOD Configuration Management Program, pre-pricing vs ceiling pricing for major changes, past change control efforts observed by the contractors and the government, and original ideas/concepts that could help resolve the problem of major change in weapon system production contracts.

Lack of travel funds forced a revision to the initial data collection approach and a decision was made to send questionnaires to the change principals for twenty-two systems and to interview the change principals from one system selected from each service. The purposes of the interviews was to validate and otherwise support the questionnaire response data. The original interview questions were used to develop a questionnaire that covered such areas as definition of major change, causes of major changes, causes of constructive changes, the DOD Configuration Management Program, pre-pricing vs ceiling pricing of major changes, change control efforts observed by contractors and the government, and new ideas/concepts for resolving/

reducing the problem of major changes. Similar but separate questionnaires were developed for each of the change principals. The questionnaires contained two special features. First, recipients were asked not to identify themselves nor their organization. Second, the recipients were provided with a collect telephone number to call if they had any questions concerning any part of the questionnaire.

In order to ascertain the effectiveness of the proposed questionnaire, it was field-tested in the Washington, D.C. area by fifteen members of a graduate course in Pricing and Negotiation at The George Washington University and the questionnaire was sent to twenty-two persons performing government project manager, contractor project manager, government procuring contracting officer or government administrative contracting officer functions. The graduate students were personally instructed as to the types of comments or suggestions desired and were provided with self-addressed stamped return envelopes. The twenty-two other recipients were provided with memorandum instructions and were also provided with self-addressed stamped return envelopes. A total of twenty-five test questionnaires were returned, with seven from students and the balance from those involved in defense weapon system acquisition.

As a result of constructive comments obtained from the test, terms and connotations were clarified, some questions were reworded and some response choices were

scaled rather than presented in a yes/no context. The resulting four final questionnaires are found as Appendices A, B, C and D to this report.

Concerning sample design, it was considered feasible to query all of the change principals involved with the large in-production systems found in the Selected Acquisition Reports. Those twenty-five systems were valued at over sixty-three billion dollars and had experienced cost growth (excluding quantity changes) through December 31, 1972, of over sixteen billion dollars. Appendix E is a listing of the in-production systems selected, showing current cost estimates and cost growth (excluding quantity) through December 31, 1972. The advantages of using this size and type of sample were: (1) all services were represented, (2) all types of weapon systems were represented, (3) all types of defense industries were represented, and (4) the twenty-five systems were produced in all parts of the country.

Change principals for one system from each service were selected for interviews. These selections included different type weapon systems produced by different industries in different parts of the country.

A total of eighty-two questionnaires were sent to change principals. In a few cases individuals were the procuring or administrative contracting officer for more than one system, but were sent only one questionnaire. The questionnaires were covered with a letter explaining the

purpose of the questionnaire and a letter of introduction from Deputy Assistant Secretary of Defense (Procurement) J.M. Malloy. The letter of introduction from Mr. Malloy and the covering letter are found as Appendices F and G of this report. The covering letter also explained the feature of anonymity connected with the questionnaire process. A total of sixty-five questionnaire/interview responses were received, providing a 70% response. All responses were usable. This percentage response is considered representative of the major change universe since the change principals of all large systems were queried. All responses are retained in the files of the author.

Regarding interview technique, the prospective interviewees were first called and a time and date for the interview arranged. The telephone calls were confirmed by a letter which forwarded a letter from Deputy Assistant Secretary of Defense (Procurement) J.M. Malloy, requesting that interviews be granted. A copy of this second Malloy letter is found as Appendix H to this report. Copies of the questionnaire forms were modified for use as interview guides in order to provide uniformity of data between the interview responses and the questionnaire responses.

The analysis of data was simple and straightforward. Questionnaire and interview responses were separated by change principal type and summarized.

Secondary data was obtained from libraries at the Congress of the United States, The George Washington University, the Commission on Government Procurement, the Pentagon, the Naval Supply Systems Command and the Defense Systems Management School at Fort Belvoir, Virginia. Secondary data was also obtained from the Directorate for Information Operations, Office of the Assistant Secretary of Defense (Comptroller).

The research methodology described in this chapter possesses some limitations that must be noted. First, most of the primary data was obtained by questionnaire. Questionnaires have basic weaknesses in the necessity for interpretation of the questions by the respondents and for the interpretation of the response by the researcher. The former problem was somewhat alleviated by a pre-test of the questionnaire and by providing the respondents with a collect telephone number to call if necessary. The latter problem of interpretation of response was somewhat lessened since the respondents and the researcher communicated in an "acquisition" language. Second, questionnaires tend to encourage shorter responses than are desired. Finally, there is difficulty in assuring an interviewee of his/her anonymity. Although anonymity is promised, it is difficult for interviewees to point out weaknesses in their organizations or report past errors when a possibility exists that their superiors may find out this information and require undue explanation.

In summary, the research methodology involved the use of questionnaires and interviews to find the causes of major changes directly from the principals. These change principals were the government project manager, the contractor's project manager, and the government procuring and administrative contracting officers. The questionnaire/interview approach was used to canvas all of the change principals involved with large in-production systems. The response received was considered to be representative of the major change universe. The weakness of the questionnaire approach was noted as a research methodology limitation.

CHAPTER IV

THE ROLE OF CONFIGURATION MANAGEMENT

About 1962 the military services began experiencing serious difficulties in the management of configuration control in major weapon system acquisition. Studies showed that the total costs of engineering change proposals (ECP's) were not known at the time of approval, specifications were inadequate for configuration needs, approved changes were not incorporated promptly, and configuration practices caused misunderstanding and delays within the Department of Defense and for a large number of defense contractors.¹

A 1964 Logistics Management Institute (LMI) study found that engineering change proposals accounted for 20% of cost growth and 80% of all changes in weapon system contracts.² It concluded that increased program costs were caused by failure to consider all the factors in making change decisions, by lack of uniformity in DOD change practices, and by procedures in use failing to assure prompt change processing, decision and implementation.³

¹Edward J. Engoron and Albert L. Jackson, Jr. "Uniform Policy and Guidance Established for Configuration Management," Defense Industry Bulletin, January, 1969, p.2.

²Ibid., p. 1.

³Ibid.

These problems and others forced the Department of Defense in mid-1968 to issue directives providing authoritative policy and implementation guidance for a new DOD Configuration Management Program.⁴

This chapter will focus on the relationship of configuration/engineering change management to the overall problem of major changes in weapon system production contracts. First, the new Department of Defense Configuration Management Program will be described, including an explanation of the types and classes of engineering change proposals and priorities assigned for handling them. Next, the manner in which the new program has been implemented by the Services will be reviewed. Finally, the observed results of the configuration management program will be examined and continuing configuration management problems will be analyzed.

Configuration Management is a discipline which integrates the technical and administrative actions of identifying and documenting the functional and physical characteristics of an item during its life cycle, controlling changes proposed to these characteristics, and providing information on the status of change actions.⁵ It can be

⁴U.S. Department of Defense. Configuration Management. DOD Instruction 5010.19. Washington, D.C.: Department of Defense, July 17, 1968.

⁵Engoren and Jackson, Uniform Policy and Guidance, p. 1.

thought of as the means through which the integrity and continuity of the design, engineering and cost trade-off decisions made on technical performance, producibility, operability and supportability are recorded, communicated and controlled by program and functional managers.⁶

The four essential functions of configuration management are: (1) identification and documentation, (2) audit, (3) status accounting, and (4) change control. This study is particularly interested in the change control function and its relationship to major changes.

The purpose of change control is to prevent unnecessary or marginal changes while expediting the approval and implementation of the worthwhile ones. Worthwhile changes are considered to be those which will: correct deficiencies, significantly improve operational effectiveness or reduce logistic support requirements, result in substantial life cycle cost savings, and prevent slippage in an approved production schedule.⁷

The methodology by which the Configuration Management and Change Control Programs operate is the Engineering Change Proposal (ECP) procedure. Before explaining how the ECP procedure is utilized by the Services, the types and classes of and priorities for ECP's will be examined.

⁶Ibid.

⁷Ibid., p. 3.

The following are different types of changes that are processed as ECPs: (1) Product Improvement Proposals (PIP's), (2) Value Engineering Proposals (VEP's), (3) Value Engineering Change Proposals (VECP's) and (4) Equipment Improvement Recommendations (EIR's).⁸

James Reece has delineated six types of engineering change proposals (ECP's). They are: (1) correction of deficiency, (2) improvement change, (3) state-of-the-art advance, (4) value-engineering change, (5) optional accessory changes, and (6) gold-plating changes. Correction of deficiency changes arise when the customer determines that an item is not meeting some contractual requirement and chooses to demand a contractor fix rather than relaxing the requirement. An improvement change involves the government's not really knowing what it wants the contractor to do. State-of-the-art advances are the result of establishing the feasibility and applying certain scientific and/or engineering concepts in areas where the concepts have been previously untried. Value-engineering changes are concerned with the elimination or modification of anything that contributes to the overall cost of an item or task without contributing to its performance. Optional accessory changes are changes which represent system capability which were

⁸U.S. Department of Defense. Research and Development Configuration Management. Army Publication 70-37. Washington, D.C.: Department of the Army, June 1, 1969, pp. 2-5.

considered desirable at the time the initial program was planned but which, if they were included in the original program, might add enough marginal cost to prevent the program from receiving approval within the Department of Defense or Congress. Gold-plating changes involve improvements for which incremental benefits do not justify the incremental cost.⁹

Engineering change proposals are of two classes. Class I changes are those which affect: (1) contractual specification, **target** cost or fee, weight, guarantees, delivery or test schedule, (2) contractual reliability and/or maintainability requirements, (3) performance as stated either in definite terms or goals, or as experienced in items in service, (4) interchangeability or change in category regarding substitutability or replacement, (5) safety, (6) electrical interface to communications-electronic equipment or electromagnetic radiation hazards, (7) aerospace ground equipment/support equipment, training devices or GFE, (8) preset adjustments or preset schedules to the extent that new identification must be assigned, or operating limits are affected, (9) weapons, systems, equipment or facilities **produced** by one contractor to the extent that the affected

⁹James S. Reece. The Effect of Contract Changes On the Control of a Major Defense Weapon System Program. Unpublished DBA dissertation, Harvard University, May, 1970, pp. 2-18.

other contractor must accomplish an engineering change to maintain capability at the interface, and (10) operational computer problems.¹⁰

Class II changes are those which have to do with: (1) record changes, (2) liaison engineering changes, (3) minor improvement changes, or (4) changes necessary to complete or correct the original design.¹¹

Engineering change proposals are processed according to their relative importance. The three priority categories that have been established by DOD are emergency, urgent and routine. A complete breakdown of the priority categories is found as Appendix I of this report.

The four basic criteria considered in the evaluation of engineering change proposals are: (1) correction of deficiencies, (2) incorporation of changes in operational or logistic support characteristics, (3) effecting substantial life cycle cost savings, and (4) relieving production slippages.¹²

The Department of Defense Configuration Management Program, although structured, allows the services to implement their own individualized configuration management programs.

¹⁰Ibid., p. 4-1.

¹¹Ibid., p. 4-3.

¹²Research and Development Configuration Management.
AR 70-37, p. 2-4.

The Army manages its configuration management program through the Army Materiel Command (AMC). The Director of Development and Engineering at Headquarters AMC is chairman of the AMC Configuration Control Board and promulgates policy to the major project managers and commodity commands under the command of AMC. Each major project manager that reports directly to the Commanding General of AMC has his own configuration management organization and configuration control board. Army project managers that report to the commodity commands (Missile, Aviation, Tank ~~Automotive~~, etc.) also have their own configuration management organization, but utilize the configuration control boards of their parent commodity commands.¹³ Figure 5 shows the typical engineering change proposal loop in the Army. Note that although the diagram shows that the contractor originates the ECP, in many cases the Army develops the ECP and submits it to the contractor for formal submission under the configuration management program.

Army ECP's may be approved at the field level (commodity commands) except for those that: (1) are requests for deviation/waiver that involve a major defect, (2) affect a basic readiness operational capability, (3) affect the

¹³U.S. Department of Defense. Research and Development Configuration Management. Army Materiel Command Supplement #1 to AR 70-37. Washington, D.C.: Department of the Army, June 23, 1970, pp. 1-3.

TYPICAL ENGINEERING CHANGE PROPOSAL LOOP

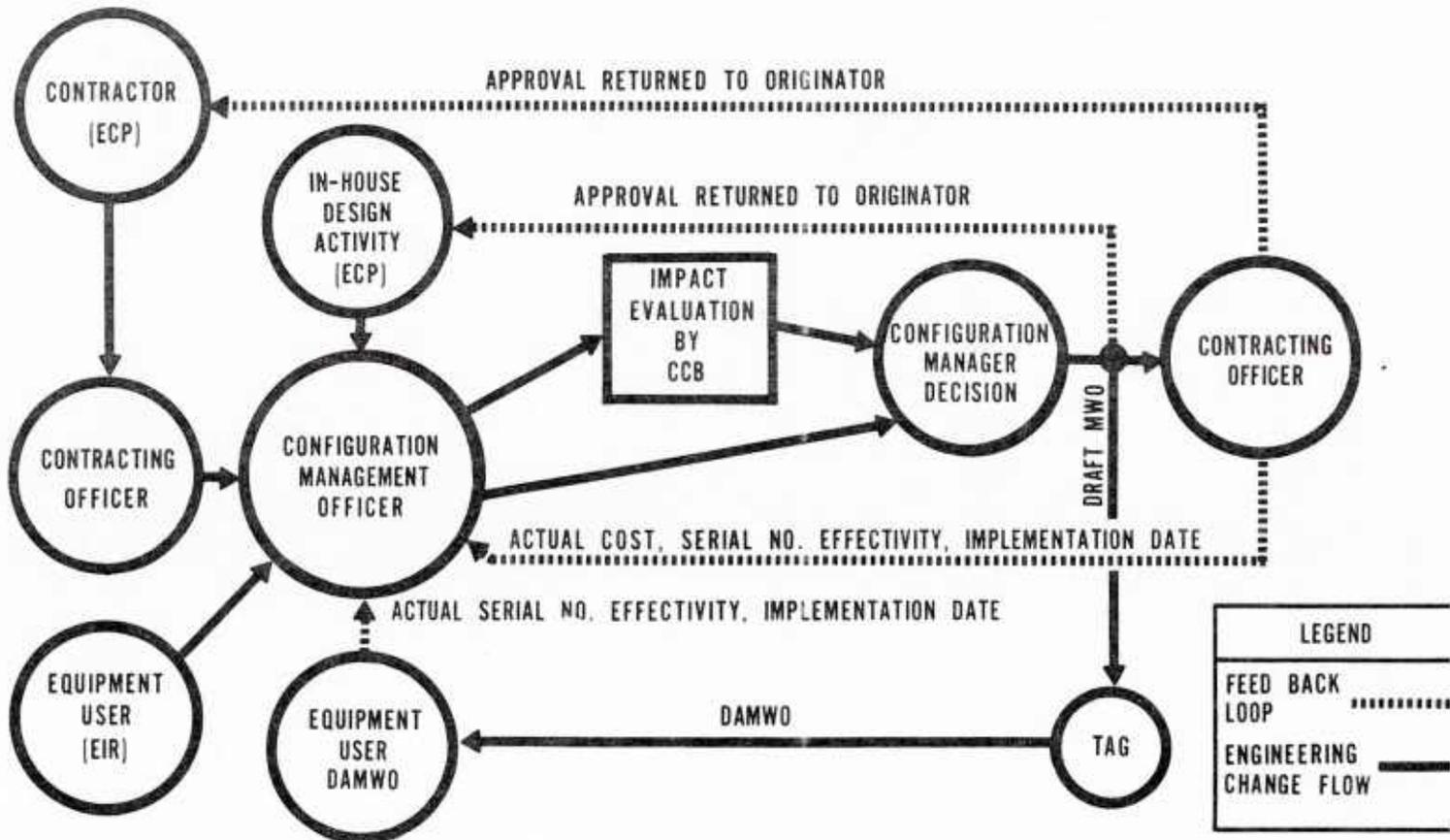


Figure 5

Five Year Development Plan (FYDP), or (4) involve a product improvement plan with an annual cost of over \$2 million.¹⁴

The Army Configuration Management Program is regulated by publication AR 70-37. Supplements to this basic publication are issued by the Army Materiel Command and commodity commands.

The Air Force Configuration Management Program operates in a very structured manner. The Air Force Systems Command (Deputy Chief of Staff, Systems) has been tasked with the configuration management responsibility for the Air Force. The Air Force Systems Command (AFSC), in turn, has delegated authority and responsibility for configuration management to its Divisions (Aeronautical, Electronics, Space and Missile, etc.), Centers and System Project Offices. Each system project office has its own configuration management division and configuration control boards.¹⁵ Figure 6 shows the flow of a typical Air Force engineering change proposal. While Air Force system project offices carry on necessary liaison with other interested Air Force organizations, it is interesting to understand that each system project office is functionally organized and staffed to internally process and develop a reply to ECP's from contractors. As was the

¹⁴U.S. Department of Defense. U.S. Army Materiel Command Configuration Change Board. Army Materiel Command Memorandum #15-28. Washington, D.C.: Department of the Army, May 28, 1970, pp. 1-3.

¹⁵U.S. Department of Defense. Configuration Management during Definition and Acquisition Phases. Air Force Systems Command Manual 371-1. Washington, D.C.: Department of the Air Force, January 1, 1964, p. 7.

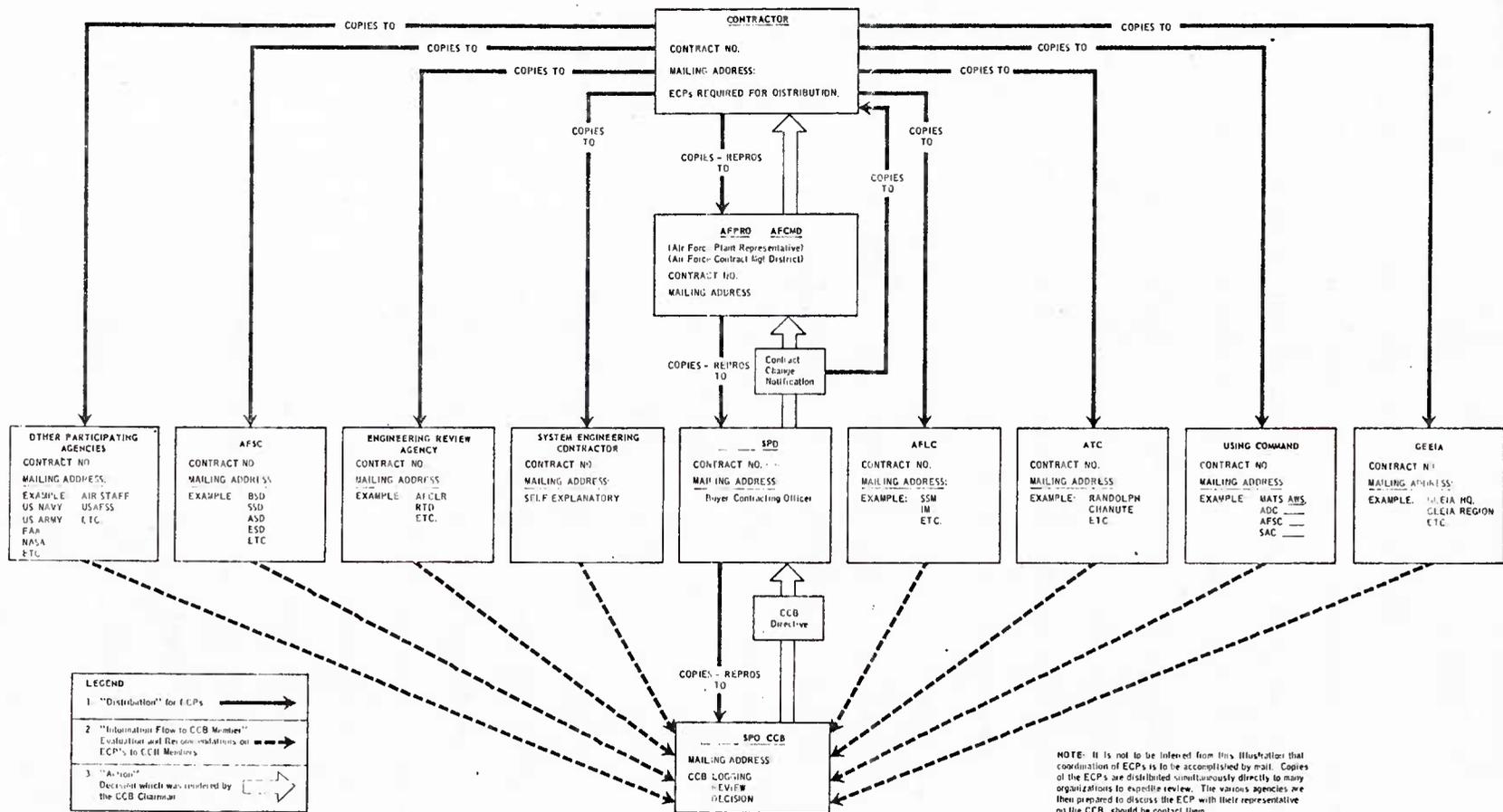


Fig. 6

Typical Air Force Change Proposal Flow

case with the Army, some ECP's are developed within the Air Force and sent to the contractor for formal processing.

The Air Force Configuration Management Program is regulated by Air Force System Command publications 375-1, which was originally written in 1962 and is considered to be the genesis of the DOD Configuration Management Program.

The Navy Configuration Management Program is different in many ways from the Army and Air Force Programs. This difference arises from the Navy's organization for weapon system acquisition. In the Navy the customers for weapon systems are represented by the Office of the Chief of Naval Operations. The Acquisition Commands (Naval Air Systems, Naval Ship Systems, Naval Ordnance Systems and Naval Electronic Systems) functionally work for the Chief of Naval Material, who is on the logistics side of the house. The Chief of Naval Material (Deputy for Procurement and Production) has the responsibility for configuration management in the Navy and delegates the authority and responsibility to the acquisition commands. Navy project managers, even those few who report directly to the Chief of Naval Material, derive their configuration management guidance and support from their applicable System Command (Air, Ships, Ordnance, etc.). It is interesting to note that Navy project managers are traditionally provided with small, internal staffs and receive functional support from their parent system commands. For this reason, the processing of engineering change proposals is more cumbersome

and time-consuming in the Navy. Because of this major difference, the configuration management operation for each Navy System Command will be described separately.

Figure 7 shows the processing flow for an engineering change proposal within the Naval Air Systems Command (NAVAIR). Within NAVAIR there is an Airframe Change Control Board, an Aircraft Component Change Board and a Missile Change Control Board.¹⁶ The three boards approve all ECP's for systems procured by NAVAIR. Figure 8 shows the normal processing times for ECP's within NAVAIR.

Figure 9 shows the processing flow for an engineering change proposal within the Naval Ship Systems Command (NAVSHIPS). ECP's are approved at four different levels for systems procured by NAVSHIPS. Approval of the Office of the Chief of Naval Operations is required for changes which affect the military characteristics of new ships, changes which would increase the cost of a ship project above the approved Congressional Appropriation and any change which would delay a ship beyond contract delivery date.¹⁷ NAVSHIPS Command Change Review Board approval is required for proposed changes which have inter-ship/class application and those of a reclama nature. Ship Acquisition

¹⁶U.S. Department of Defense. Change Control. Naval Material Command Briefing Paper. Washington, D.C.: Department of the Navy, August 4, 1970, p. 18.

¹⁷Ibid., p. 22.

PROCESSING FLOW OF ENGINEERING CHANGE PROPOSALS WITHIN NAVAIR

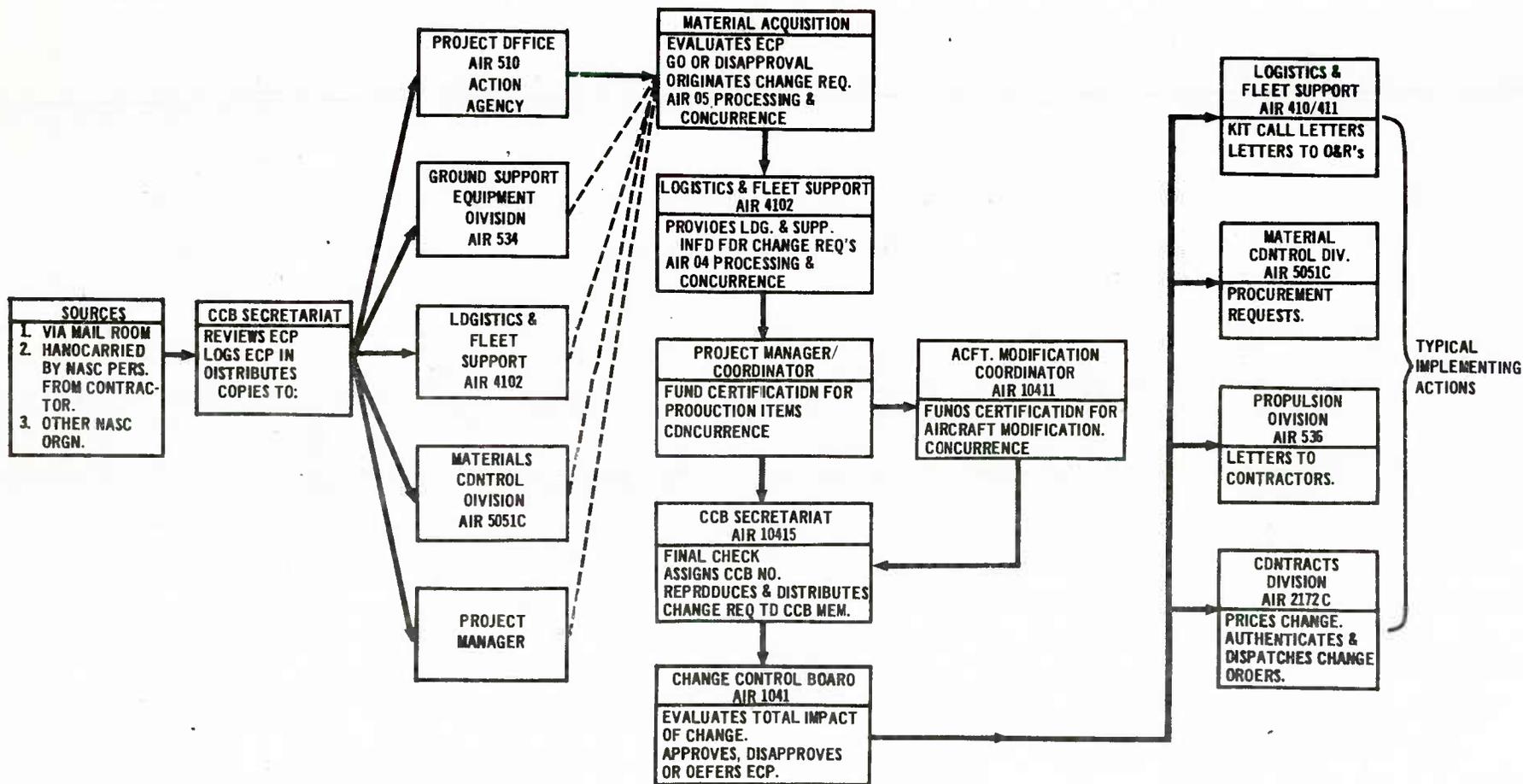


FIGURE 7

ENGINEERING CHANGE PROPOSAL FLOW PROCESSING WITHIN NAVAIR

	5 DAYS	24 DAYS	5 DAYS	1 DAY	10 DAYS
LOGS & DISTRIBUTES ECPs	PRELIMINARY REVIEW PM DECIDES GO/NO GO. IF GO HE ESTABLISHES A CCB DATE	TECH EVAL COST EFFECTIVENESS PREPARATION OF CCB FORMS & COORDINATION	TEAM REVIEW WITHIN 5 DAYS OF CCB	APPROVAL OR DISAPPROVAL	IMPLEMENTING ACTIONS

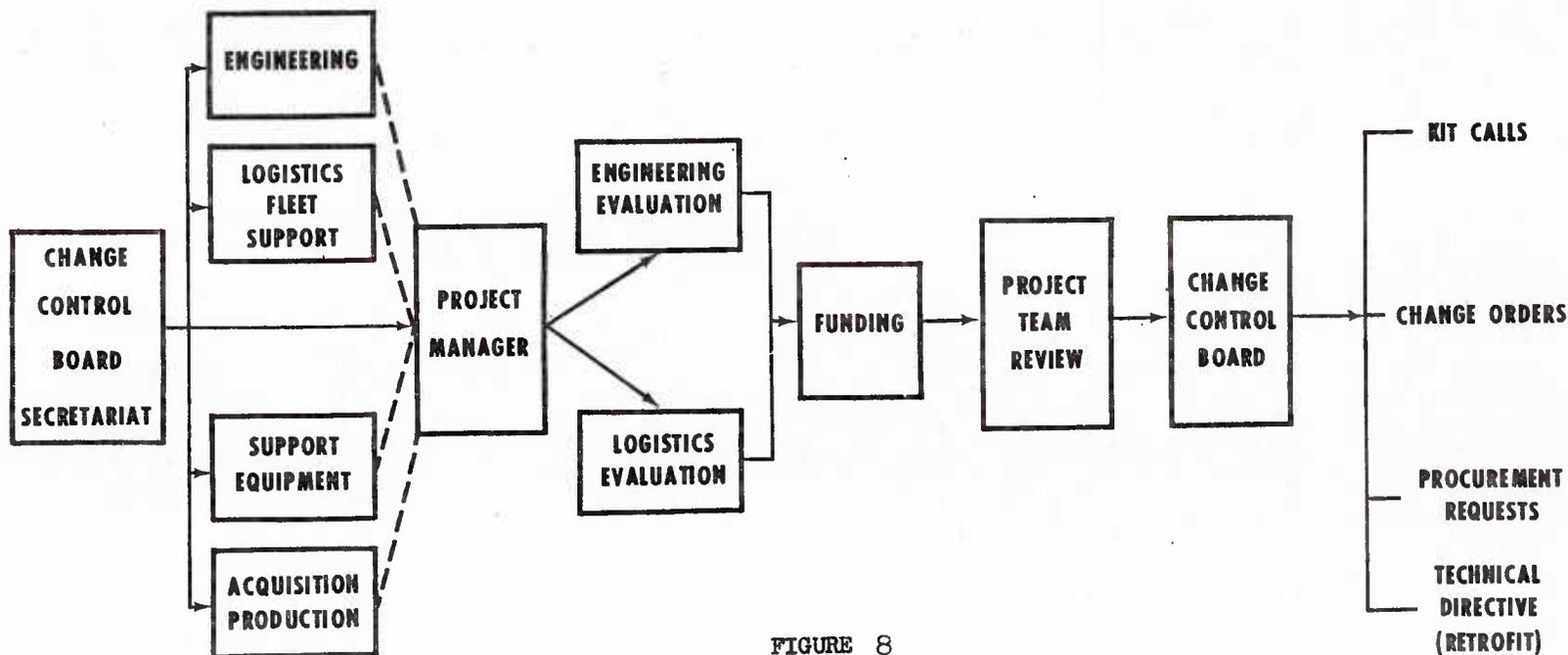


FIGURE 8

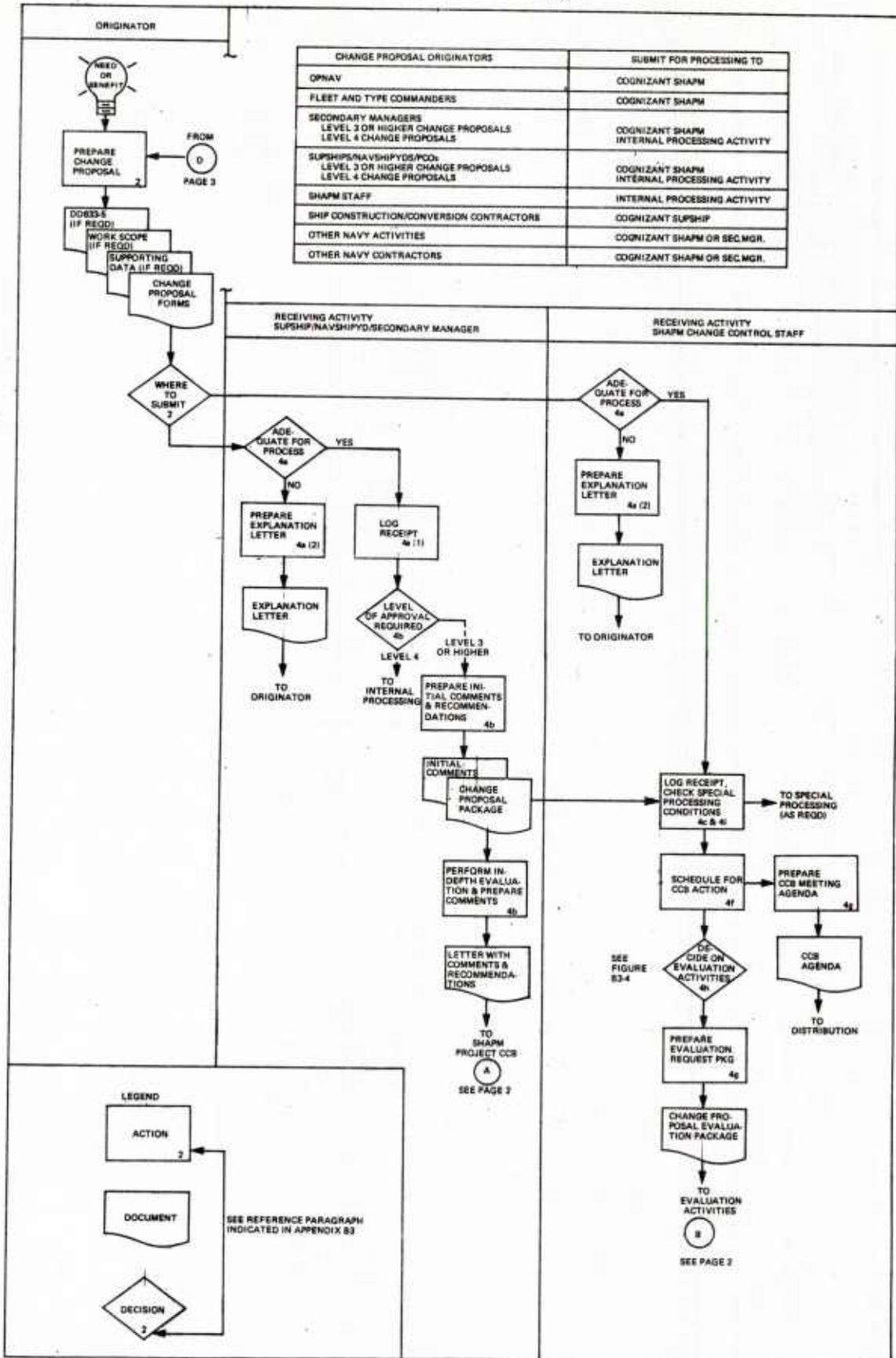


FIGURE 9 NAVSHIPS ECP FLOW

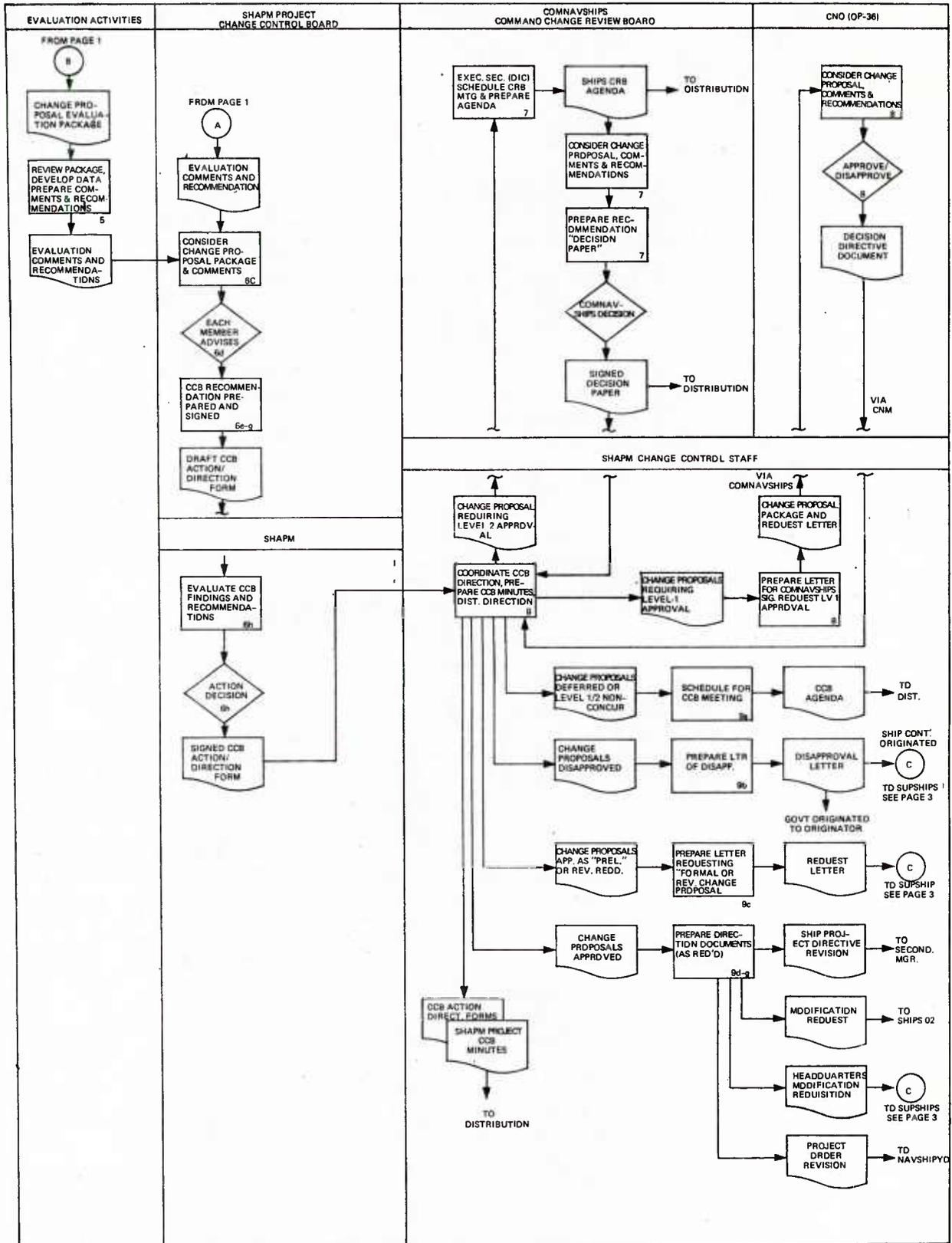


Figure 9 continued

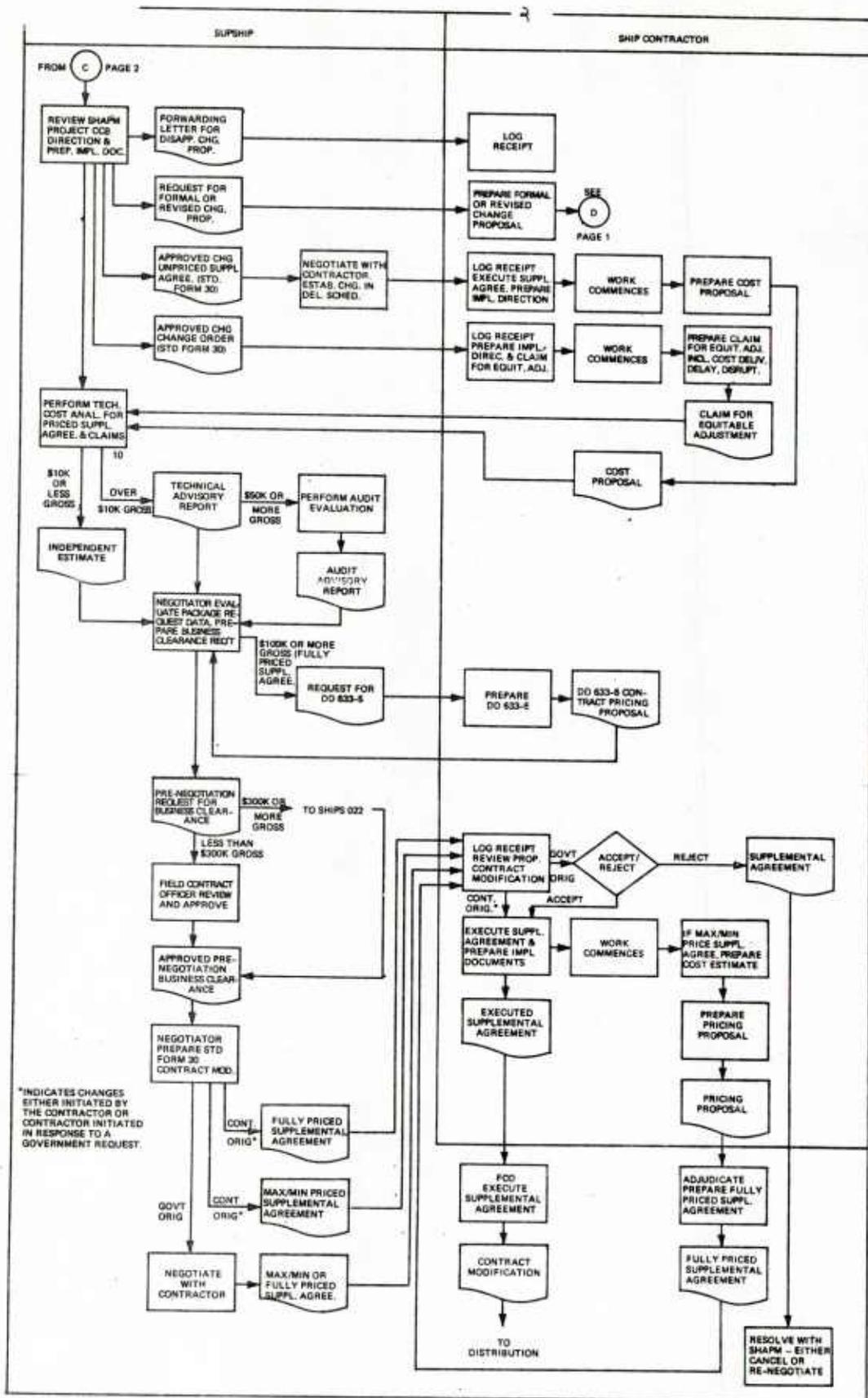


Figure 9 continued

Project Managers (SHAPM's) approve normal ECP's and the Navy Offices of the Navy Supervisors of Shipbuilding, located at the contractor's yards, have authority to approve ECP's of lesser technical complexity and those that have a gross cost decrease or increase of less than \$10,000.¹⁸ Configuration control is a serious problem in ship systems due to the large number of subsystems involved. Figure 10 shows the complicated matrix of change proposal evaluation responsibilities for ship systems. In this diagram secondary managers are the managers of aircraft, ordnance, missiles, and/or electronics which operate on and in a ship.

Figure 11 shows the change control organization for the Naval Ordnance System Command (NAVORD). Note the interface on the bottom of the diagram between NAVORD and the ship acquisition project managers. In NAVORD there are three Change Control Boards: (1) Undersea Warfare Systems Board, (2) Anti-Air Warfare Systems Board, and (3) Surface Warfare Systems Board.¹⁹

Figure 12 shows the change control organization for the Naval Electronics Systems Command (NAVELEX). Note again the interface at the bottom of this diagram between NAVEXLEX and the ship acquisition project managers.

¹⁸Ibid., p. 24.

¹⁹Ibid., p. 32.

MATRIX OF CHANGE PROPOSAL EVALUATION RESPONSIBILITIES

FACTORS → FUNCTIONS ↓	PROGRAM IMPACT			TECHNICAL IMPACT													ILS IMPACT					PROD. IMPACT			CONTRACT IMPACT			RETROFIT/ BACKFIT											
	MILITARY CHACT.	PROGRAM SCHEDULE	BUOGET	NECESSARY/ FEASIBLE	ALTERNATE SOLUTIONS	SHIP SYSTEM PERFORM.	SHIP SUBSYS PERFORM.	GFE	INVENTORY EQUIP.	SUPPORT EQUIP.	TEST EQUIP.	FACILITIES	TOP SIDE ARRANGE.	CLC SPACE ARRANGE.	WEIGHT & MOMENT	SURVIV- ABILITY	SAFETY	R&M	STANOARD- IZATION	SPECS & DWGS	NO DWGS	GFI	OTHER NAVY PROJECTS	MAINTE- NANCE	SPARES/ REPAIR PTS.	TECH. MANUALS	TRAINING		PERSONNEL	LIFE CYCLE COST	CUT-IN POINT	TEST PLANS	PROG. PLAN	WORK SCOPE	COST EST.	DELIVERY DATE			
SHAPM PROJECT OFFICE STAFF	•	•	•	•	•	•	•				•				•	•	•	•	•			•		•	•	•	•	•	•	•	•	•	•	•	•	•			
NAVSEC (COG. DESIGN CODE)				•	•	•									•	•	•	•	•				•																
SHIP LOG. MGR. (SHIPS 04)																								•	•	•	•	•										•	
SECONDARY MANAGER (S)				•	•		•	•	•	•					•	•	•	•	•			•	•	•	•	•	•	•										•	
SPECIFICATION CONTROL BD.																			•	•		•																	
SHIPS 06G													•																										
NAVORD												•																											
NAVELEX										•																													
SEC 6133														•																									
SHIPS 0613																																						•	
SPCC/ESO/ICP																								•															•
SUPSHIP				•	•						•																		•	•	•	•	•	•	•	•	•		
TYCOM/FLEET				•	•										•	•							•			•	•											•	
NAVSHIPYD (LEAD)																			•	•	•					•	•												
BUPERS																										•	•												
BUMED							•	•																															
SHIPS PMS 390								•															•																

FIGURE 10

NAVORD CHANGE CONTROL ORGANIZATIONAL LEVELS OF APPROVAL

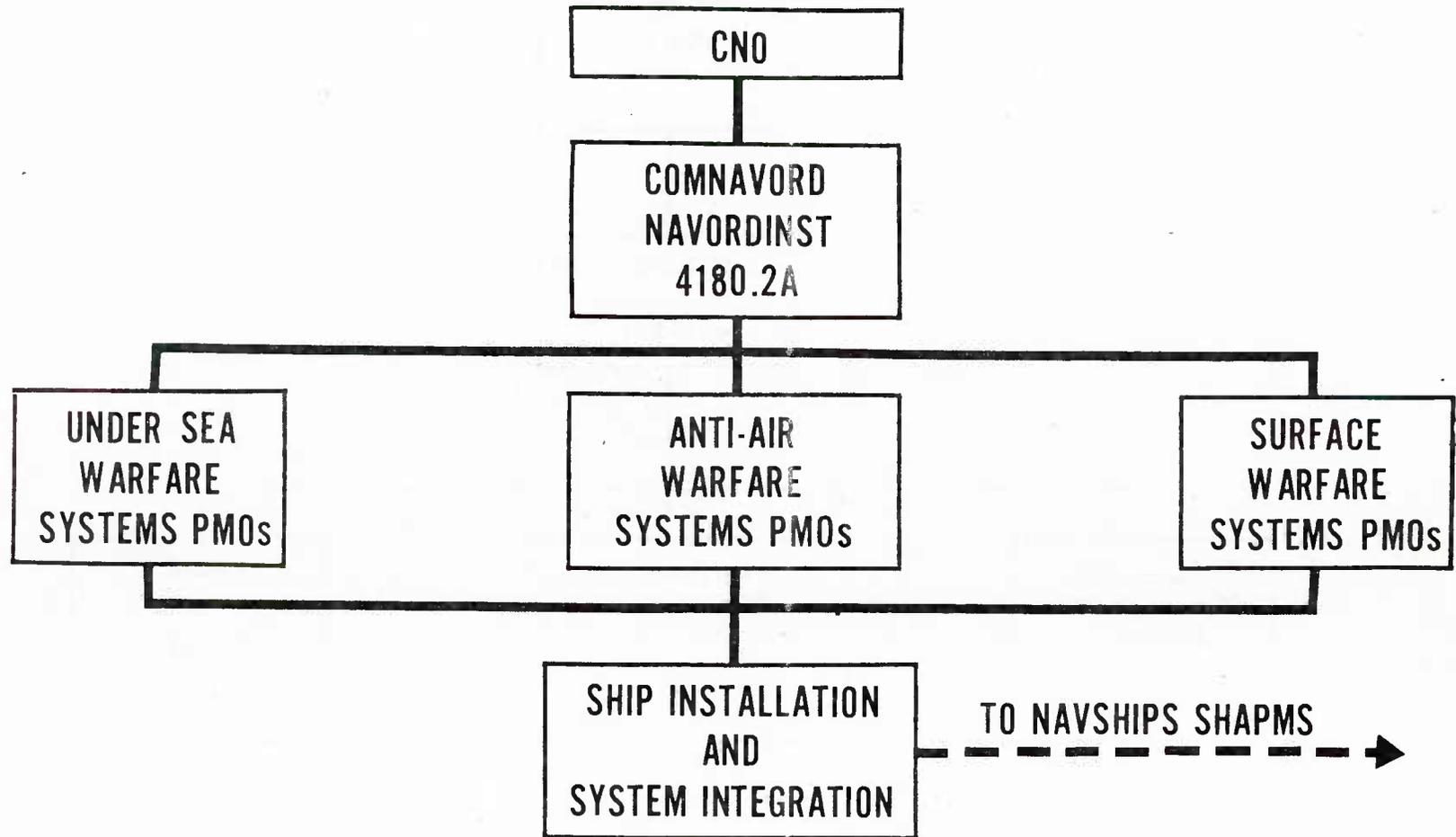


FIGURE 11

NAVELEX CHANGE CONTROL Organizational Levels of Approval

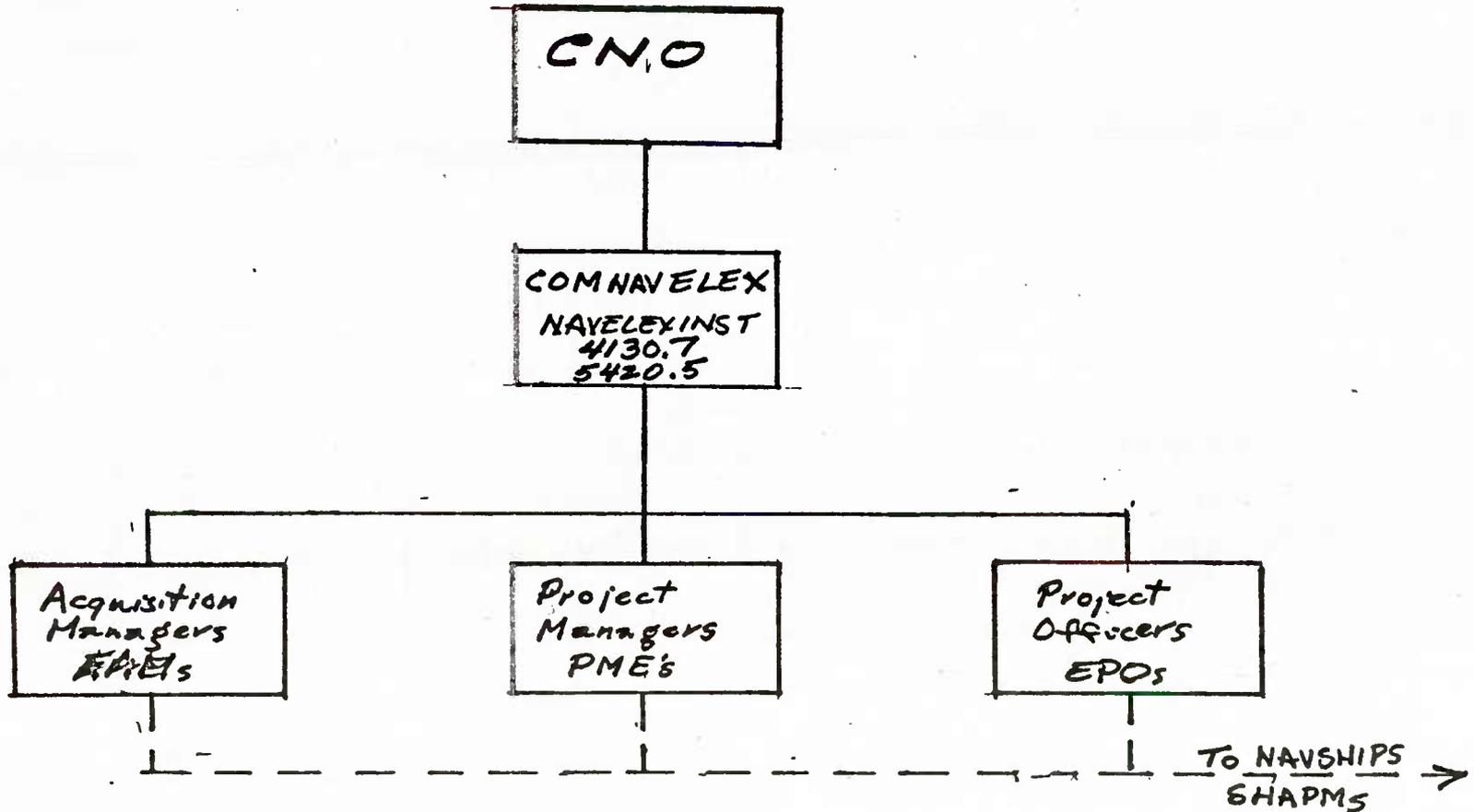


Fig. 12

After having looked at how configuration management programs operate, it is time to observe the effectiveness of their operation and to consider continuing configuration management problem areas.

The Navy has reported that better change management has resulted in fewer approved changes.²⁰ Engineering change proposals worth about \$35-40 million are being disapproved or cancelled each fiscal year as a result of comprehensive evaluation. As an example, in 1970 a missile project manager in Naval Ordnance Systems Command disapproved or cancelled \$144 million worth of ECPs in comparison to \$207 million approved.²¹

In connection with on-going configuration programs, the Navy has also developed a set of five basic questions to utilize in the preliminary evaluation of proposed changes. They are: (1) How necessary is the change? (2) What is the priority of the change? (3) What is the estimated gross or net cost of the change? (4) Have other alternatives been considered over and above the proposed change? (5) What is the impact of the change on scheduled contract deliveries?²² A complete breakdown of these five basic questions and their

²⁰Ibid., p. 38.

²¹Ibid.

²²U.S. Department of Defense. Principles of Management of Change Within the Navy. Chief of Naval Material Paper. Washington, D.C.: Department of the Navy, April 13, 1971, pp. 12-13.

sub-questions is found as Appendix J to this report. Wise use of these questions can help eliminate unnecessary changes before they reach the ECP stage.

Regarding continuing problems in configuration management, all of the services report difficulty in meeting the DOD processing time standards, not so much in the basic processing of the ECP, but in contractually pricing changes within the allotted time frames. Some suggestions have been made by the services to separate the evaluation from the final pricing phases, but the fact remains that exorbitant final pricing may be the factor that defeats a change proposal.

The Navy is continuing to experience processing time problems largely because of its complicated review cycle, as shown in Figures 7 through 12. Also, the Navy is experiencing configuration problems because of new anti-claims clauses inserted into more recent production contracts. These clauses require the contractor to make "problem identification reports" to the contracting officer on all potential performance problems. Many of these potential problem situations had been handled previously as ECP's and now must go through a "problem identification" cycle before they begin the change proposal review cycle.

The Army is experiencing a new configuration problem associated with a new DOD policy to utilize competitive prototypes in the advanced development stage of acquisition. This new approach means that formal configuration management

cannot begin on a system until after completion of the advanced development stage. Under this concept it will be necessary to reconstruct the contractors' specification changes during advanced development to determine a functional configuration baseline.

Besides the new problem with configuration management in competitive prototypes, the Air Force is also experiencing a problem with computer programs procured as a separate contract line item and "configuration" item in weapon system contracts. While these computer programs require configuration control monitored by the Air Force System Command, the programs are under the operational control of the Air Force Logistic Command. The Air Force, in trying to resolve the processing time problem, has proposed a new "need date" concept wherein the configuration control board would establish a realistic date by which ECP evaluation would be completed, including pricing.

In summary, this chapter has focused on the relationship of configuration/engineering change management to the overall problem of major changes in weapon system production contracts. It was shown that in about 1964 the Department of Defense recognized major problems in configuration management and as a result developed a coordinated configuration management program that forced the services to provide intelligent and efficient evaluation of engineering changes proposed either by the contractor or by the government itself. The DOD Configuration

Management Program was reviewed, including a comparison of how the program operates in each service. Finally, the positive effects of configuration management were measured and consideration was given to continuing problems which still must be resolved.

Conclusions and recommendations concerning the continued role of configuration management, developed from empirical research, will be presented in Chapters VI through IX.

CHAPTER V

THE ROLE OF CONSTRUCTIVE CHANGES

Between 1967 and 1971 defense contractors submitted over \$1 billion in claims to the Navy and the Armed Services Board of Contract Appeals for what they considered to be constructive changes in large Navy contracts.¹ Although some of these contracts involved research and development efforts, the majority of them were for fixed-price production contracts for major weapon systems, particularly ships.

This chapter will focus on the special role of constructive changes in major weapon system production contracts. The nature of constructive changes will be examined, along with the rationale for the government's acceptance and payment of claims resulting from constructive changes. The major types of constructive changes will be analyzed and the resultant types and amounts of contractor's claims will be reviewed. This chapter will also review the efforts made by the Department of Defense, particularly by the Navy, to control the continuing occurrence of constructive changes.

¹U.S. Department of Defense. Naval Material Command. Navy Claims. Chief of Naval Material, memorandum, April 3, 1973, encl. 1.

A constructive change order is defined as any conduct by a government representative which is not a formal change order, but which has the effect of requiring the contractor to perform work different from that prescribed by the original terms of the contract. The applicable government representatives may be inspectors, engineers from headquarters, or in the field, personnel at government quality control laboratories, or even the procuring or administrative contracting officers themselves. A constructive change may result from a failure to act as well as from a positive course of conduct.²

The Armed Services Board of Contract Appeals and the U.S. Court of Claims have recognized the existence of constructive changes for some time. There is rationale for the Board and the Courts to grant such a vehicle of relief. First, there is a basic fairness in giving relief in these kinds of situations. Legally, it would appear that the Government has the right to insist on a literal application of the changes clause. Just because a formal written change wasn't issued doesn't overcome the fact that the contracting officer or his authorized representative knew or should have known that the contractor was relying on informal

²U.S. Department of Defense. Headquarters Naval Material Command Procurement Newsletter, May-June, 1969, pp. 1-2.

direction from a government representative.³ Even assuming the absence of a legal basis, relief has been justified under the well-established principle of "Equity". A cardinal equity principle is "that is done that ought to be done." Quite simply, this means that if work was ordered that could have been under the changes clause, then it will be treated as if it were ordered that way. The Board and the Courts have found that the unilateral right of the government to make changes in contracts opens the door for constructive changes.⁴

The Office of the Chief of Naval Material has identified the principal categories of constructive changes and they will now be briefly reviewed.⁵

A constructive change can result from specifications or contract provisions which are "impossible of performance" in whole or in part under a production type contract because they require work beyond the state-of-the-art and involve research and development effort. In this case, unless such specifications are promptly relaxed, the contractor is entitled to compensation for his efforts to meet such "impossible" requirements, including the effects of delays and disruptions in contract performance.

³Ibid., p. 2.

⁴Ibid.

⁵U.S. Department of Defense. Naval Material Command. Constructive Change Orders in the Navy. Chief of Naval Material memorandum, September 3, 1969, pp. 1-3.

Constructive changes can also result from specifications or contract provisions which are impossible or defective because of conflicting or erroneous requirements. For example, where the government prescribes not only a space requirement of "x" square feet per man, but also other requirements for equipment or furniture in the same area which precludes providing the allotted space per man, such requirements conflict.

Specification or contract provisions can also be deficient in that they are worded in general terms, are unclear, or are open to more than one interpretation or application. The problem here is, absent a disclaimer provision, the current administrative and judicial rule is that the contractor's interpretation of an ambiguity governs as long as it is not unreasonable, and if the contractor has been directed to follow the Government's interpretation and it is more costly, he can recover the difference.

In another type constructive change, drawings may be defective in that they contain errors, omissions, inaccuracies or inconsistencies. Examples of such defects are incomplete drawings and microfilm from which legible drawings cannot be reproduced. In this case, the contractor can recover the extra costs, including those flowing from delays and disruptions, arising on account of such defective drawings.

Government provided information or documentation which is late, defective or subsequently revised can cause constructive changes. Such documentation forms a part of the specifications or is governed by the standard government property clause of the contract. In either event, the contractor needs the information to accomplish his work. If the documentation is late, defective, or revised after he starts work in accordance with the original contract requirements, the contractor may claim for the delay or extra work or both, and can recover legitimate additional costs.

Improper acceleration of work is another type of constructive change. It occurs where the government insists that the contract delivery schedules be met despite the contractor's valid claim of excusable delay entitling him to an extension of time to perform.

Constructive changes sometimes involve inspection, quality assurance and rejection of work. Examples of such changes are: (1) an inspector requirement in inspection and testing which is a departure from previous practice without a corresponding change in the specifications or other provisions of the contract, (2) an inspector's erroneous interpretation of test specifications, procedures, methods, conditions or results, or (3) requirements imposed by inspection personnel that go beyond any reasonable interpretation of the specifications.

Technical direction by personnel other than contracting officers can also constitute a constructive change. Government technical administrators, in the course of contract administration, are frequently called upon to make technical decisions involving interpretations, clarifications, and correction of specifications and possibly even changing the specifications. Such decisions may subsequently result in constructive changes.

Now that the principle categories of constructive changes have been reviewed, it is interesting to observe which categories appear in large claims from contractors. Table 16 is a partial listing of high dollar value Navy claims received between 1966 and 1969, showing the weapon system, contractor, amount claimed and the kind of constructive change alleged. While no definite conclusions can be reached from this limited sample of twenty-one claims totaling about \$340 million dollars, it is interesting to note that erroneous or defective specifications/drawings (alleged in thirteen claims) and technical direction not from the contracting officer (alleged in ten cases) were the most prevalent reasons for claims. Because some of these large claims were separated into unrecognizable parts and some were combined with other related claims, it is impossible to determine what percentage of the original claims were determined to be valid and subsequently allowed. Also, if disallowed by the Navy, some of these claims may have been submitted to the Armed Services Board of Contract

TABLE 16

SOME HIGH-DOLLAR VALUE NAVY CLAIMS
RECEIVED 1966 thru 1969

SYSTEM	CONTRACTOR	\$ CLAIMED	KIND OF CONSTRUCTIVE CHANGE ALLEGED
Avionics	Teledyne	1,180,000	Ambiguous contract delays; Late GFP; Ripple Effects of Constructive Changes; Late Approval of Drawings
Avionics	Teledyne	2,145,000	ditto
Glide Bomb	Martin Marietta	44,432,603	Erroneous Specs.; Defective Drawings; Technical Direction from other than Contracting Officer
Missile Guidance and Control	Raytheon	15,500,000	Erroneous Specs.; Defective Drawings; Unanticipated R&D
Missile	No. American Rockwell	40,000,000	Erroneous Specs.; Delay
Torpedo	Aerojet-General	15,000,000	Erroneous Specs.; Defective Drawings; Contract Ambiguities; Acceleration; Delay; Erroneous Rejection
Ships	Lockheed Shipbuilding	7,441,999	Defective Drawings; Unanticipated R&D; Erroneous Rejection; Technical Direction not from Contracting Officer
Ship Modernization	Lockheed Shipbuilding	6,413,343	Not specified

Table 16, continued

SYSTEM	CONTRACTOR	\$ CLAIMED	KIND OF CONSTRUCTIVE CHANGE ALLEGED
Gunboats	Tcoma Boatbuilding	1,288,876	Acceleration; Erroneous Specs.; Defective Drawings; Technical Direction not from Contracting Officer
Electronics	Bendix	16,930,000	Erroneous Specs.:
Radar	Melpar	3,679,897	Ripple Effect of Constructive Change; Technical Direction not from Contracting Officer
Ships	Newport News Shipbuilding	31,533,926	Additional and Deferred Work; Acceleration; Delay; Technical Direction not from Contracting Officer
Ships	Lockheed Shipbuilding	45,191,887	Not Specified
Ships	Avondale Shipyards	26,360,000	Defective Specs.; Ambiguous Contract; Late GFM; Delayed Inspection
Ships	Lockheed Shipbuilding	24,878,871	Erroneous Specs.; Defective Drawings; Technical Direction not from Contracting Officer
Ships	Lockheed Shipbuilding	18,222,242	Defective Drawings; Erroneous Rejection; Technical Direction not from Contracting Officer; Ripple Effect; Excessive Approval Time

Table 16, continued

SYSTEM	CONTRACTOR	\$ CLAIMED	KIND OF CONSTRUCTIVE CHANGE ALLEGED
Ships	Lockheed Shipbuilding	21,154,736	Erroneous Specs.; Defective Drawings; Technical Direction not from Contracting Officer
Ships	Lockheed Shipbuilding	5,568,003	Defective Drawings Erroneous Rejections; Technical Direction not from Contracting Officer
Ship Conversion	Lockheed Shipbuilding	6,066,752	No specifics
Ship	Lockheed Shipbuilding	4,649,851	Erroneous Specs.; Technical Direction not from Contracting Officer
Ship Activities	Buck Kreihs	1,788,754	Defective Specs.
TOTAL		339,426,740	

Source: Constructive Change Orders in the Navy. Chief of Naval Material memorandum dated September 3, 1969, encl. 5, Table B.

Appeals or the U.S. Court of Claims for further judication. In fact, the Navy is still processing some large claims received as early as 1968. Table 17 shows the Age of Claims (\$1 million or over) under review by the Navy as of March, 1963. It is interesting to note from Table 17 that no million dollar or over claims were received during the first three months of 1973. Figure 13 shows the normal processing time for a multi-million dollar claim.

As was mentioned earlier, claims against Navy weapon system acquisition contracts are submitted to the Navy, to the Armed Services Board of Contract Appeals, and more recently to the U.S. Court of Claims. Table 18 shows the year-end inventory of Navy Claims (\$1 million or over) from 1967 through 1972. Of the 1972 year-end claims of \$682.8 million in review by the Navy, \$649.4 million, or 95%, were for ships and related systems.⁶

As was discussed in Chapter II, in 1970 and 1971 the Office of the Secretary of Defense initiated changes to defense procurement policy in an effort to better control cost growth in major weapon system acquisition. The provisions of Department of Defense Instruction 5000.1 required forward pricing of changes, an effort which particularly spoke to the constructive change problem. As was also mentioned

⁶U.S. Department of Defense. Naval Material Command. Navy Claims, CNM memo, April 3, 1973, encl. 1, Table 7.

TABLE 17

AGE OF CLAIMS UNDER NAVY REVIEW - MARCH 73
 (\$1 million and over)

YEAR RECEIVED	NUMBER	DOLLARS (MILLIONS)
1968	2	54.5
1969	7	311.8
1970	5	43.1
1971	18	276.6
1972	6	21.5
1973	None to Date	--
TOTAL	38	707.5

Source: Chief of Naval Material Memorandum dated
 April 3, 1973, encl. 2, p. 2.

Fig. 13 KEY MILESTONES IN CLAIM PROCESSING

	<u>COMPLETION TIME</u> (WEEKS)
<u>FACT FINDING</u>	
1- CLAIM RECEIVED	
2- CLAIM SETTLEMENT TEAM ESTABLISHED	1-4
3- CLAIM PROCESSING PLAN PREPARED	1-4
4- FACTUAL INVESTIGATION & LEGAL REVIEW	16-36
A. PRELIMINARY TECHNICAL ADVISORY REVIEW (TAR)	13-30
B. PRELIMINARY LEGAL MEMORANDUM	2-4
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NOTE: COLUMN 2 FIGURES APPLY TO MAJOR CLAIMS

TABLE 18

1972 YEAR-END INVENTORY OF NAVY CLAIMS
 (\$1 million or over)

DATE	TOTAL MIL ON HAND (\$)	UNDER MIL NAVY REVIEW (\$)	UNDER MIL ASBCA REVIEW (\$)	UNDER MIL COURT OF CLAIMS (\$)
DEC 1967	87.9	62.7	25.2	----
DEC 1968	218.2	200.3	17.9	----
DEC 1969	662.7	608.6	54.1	
DEC 1970	766.5	656.6	109.9	
DEC 1971	1201.9	1060.8	127.6	13.5
DEC 1972	1008.0	682.8	308.5	16.7

Source: Chief of Naval Material Memorandum dated April 3, 1973,
 encl. 1, chart 7.

earlier in Chapter II, if changes were necessary, they were required to be contractually priced or subjected to an established ceiling before authorization. This change was included in Section 26 of the Armed Services Procurement Regulations and all services issued internal directives to further promulgate this policy. In the case of the Army, the Commanding General of the Army Material Command issued a directive that required all changes to be issued with at least a ceiling price.⁷ The Chief of Naval Material went so far as to require his personal approval of unpriced changes over \$50,000, with the only exceptions being personal and public safety requirements, and problems of delivery or repair of GFM/GFI.⁸

The Navy, having experienced most of the constructive change problem, initiated several types of remedial steps to alleviate the problem and these steps will now be discussed.⁹

One effort made to reduce constructive changes was the improvement of the preparation of specifications. By two programs the Navy acted to improve the quality of its

⁷U.S. Department of Defense. Army Material Command. Procurement Instruction 26-204.80, June 1, 1972.

⁸U.S. Department of Defense. Naval Material Command. Unpriced Changes. Chief of Naval Material memorandum, November 8, 1973, p. 1.

⁹U.S. Department of Defense. Office of the Chief of Naval Material. Claims Briefing Book, April, 1973, pp. 8-18.

technical data furnished to contractors. Initially, procuring activities sponsored courses to train technical and engineering personnel in the proper practices in the preparation of specifications. The objectives were to promote not only clarity and accuracy, but also to emphasize harmonizing specifications with other existing specifications and with government policies. Next, the Office of the Chief of Naval Material promoted the use of a procedure called "specification review", designed to require procuring activities to take a hard look at the adequacy of the top level specifications to be used before issuing solicitations and awarding contracts, and also to match assessed risks of technical success with appropriate contractual risks, chiefly by proper selection of the method of contracting and type of contract to be invoked.¹⁰

In-process verification and review of technical data was also conducted. The Navy expanded its prior practice of "in-process verification and review" of technical data, principally engineering drawings. Many prior Navy claims involved problems encountered by successor contractors who found defects and errors in technical data packages generated by predecessor contractors. In addition, the Navy promulgated a test method whereunder the contractor assumes the financial burden of all "patent" or "obvious" defects in the data package and the government agrees to treat and price such

¹⁰Ibid., p. 9.

defects as line items of cost. The contractor is entitled to request a later equitable adjustment under the change clause only for the "latent" errors of which the parties were unaware.¹¹

In another step, training was conducted in constructive change recognition and contract administration. The offices of the Chief of Naval Material and the Counsel General of the Navy provided a saturation training program in contract administration. A five-week course was given repetitively to eight supervisors of shipbuilding offices and Navy plant representative offices where the bulk of Navy procurement dollars were administered. Single training presentations were conducted at most of the remaining Navy procuring and contract administration offices.¹²

Another unique step involved the documentation of significant contract events. By Navy Procurement Circular No. 30, contract administration offices were required to maintain a record of significant events for all contracts in excess of \$5 million and all contracts, regardless of dollar amount, concerning which the officer in charge of the contract administration office has determined that a reasonable possibility exists that a claim may be asserted. Events to be documented include: (1) delivery schedule changes or problems, (2) drawings, designs and specifications

¹¹Ibid., p. 10.

¹²Ibid., p. 9.

which are ambiguous, defective or impossible to perform, (3) differences in interpretation of contract provisions, (4) delay or disruption of contractor effort, (5) changes in methods or sequence of work, (6) late or defective government furnished property or information, (7) rejections, rework; waivers and deviations, (8) planned vs actual performance milestones, and (9) delays in government actions or inactions which have the effect of requiring the contractor to perform work different from that prescribed by the original terms of the contract. The type of information to be recorded includes: (1) the nature and pertinent circumstances of the event, (2) the date of the event and identification of government and contractor personnel involved, (3) identification of relevant documents involved, (4) the substance of oral communications, and (5) a statement concerning the possible consequences or effects of the event described upon the contract cost, schedule or technical performance, including manner or sequence of performance. These events are maintained separately as part of the contract file for possible later use in claims defense.¹³

The establishment of Claims Control Boards was another Navy step to alleviate the constructive change problem. In October, 1968, the Chief of Naval Material

¹³U.S. Department of Defense. Navy Procurement Circular No. 30, pp. 3-4.

established a Claims Control and Surveillance Group for the purposes of reviewing and recommending settlement on all claims totaling \$5 million or more.¹⁴ Gordon Rule, Director of the Navy's Procurement Control and Clearance Division, was appointed Chairman. This group functioned until January, 1972, when a Naval Material Command Claims Board was established.¹⁵ This board decided all claims less than \$10 million and recommended actions on claims over \$10 million to the Naval Material Command General Board chaired by the Chief of Naval Material.¹⁶

In 1968 the Navy implemented MIL-STD 480, a new tri-service standard for configuration control. This step resulted in better control of changes and forced the Naval Ship Systems Command to institute a "shipbuilding specification improvement program", which required a complete review and approval of master specifications utilized in shipbuilding.¹⁷

Finally, claims identification clauses were developed. In early 1970 it became evident that it was necessary to put the government back in control over some of the most

¹⁴U.S. Department of Defense. Naval Material Command. Chief of Naval Material memorandum, October 30, 1968, p. 1.

¹⁵U.S. Department of Defense. Naval Material Command. Chief of Naval Material Notice 4200, January 11, 1972, p. 1.

¹⁶Ibid.

¹⁷Claims Briefing Book, p. 18.

significant segments of contract performance. It was necessary to establish an orderly, explicit mechanism setting forth the responsibilities of both parties in constructive change situations and in handling and adjusting change orders. It was also necessary that the normal technical and budgetary controls be maintained. Because the total dollars of outstanding \$1 million-and-over claims were rising, and because a large number of extremely large procurements were pending, the Navy obtained approval from the Armed Services Procurement Regulations Committee for test use of new change control clauses.¹⁸ The following six new clauses were authorized: (1) changes, (2) total system responsibility, (3) change order accounting, (4) change order estimates, (5) waiver and release of claims, and (6) problem identification reporting.¹⁹

Because of the importance of these clauses, they will be briefly described.

The new changes clause was developed to require contractors to give prompt notice of impending or actual constructive changes as they first occur, thus giving the Navy the opportunity to: (1) evaluate the budgetary and technical impact and desirability of the change, (2) confirm or deny that a government act or failure to act constituted

¹⁸Ibid., p. 12.

¹⁹Ibid.

a constructive change, (3) direct the fashion of further performance, (4) countermand actions which could result in an unwanted constructive change, and (5) plan for funding and pricing these changes.²⁰

The total system responsibility clause is used when one or more contractors are paid to devise and develop a design for a new system, including the principal specifications and technical data for it. When the government does not materially alter these specifications prepared by the development contractor, it is felt fair for him to bear the risk of deficiencies or errors in those specifications.²¹

The change order accounting clause requires the contractor to maintain separate accounts, by job order or otherwise, for the segregable direct costs of a change order whose anticipated cost would exceed a minimum threshold, like \$100,000.²²

The change order estimates clause makes the contractor's engineering change proposal a firm offer acceptable by the Navy for sixty days after its submission. This clause also authorizes the contracting officer to request a contractor to prepare an "impact statement" for government proposed ECP's.²³

²⁰Ibid., p. 15.

²¹Ibid.

²²Ibid., p. 16.

²³Ibid.

The waiver and release of claims clause is nothing other than the long familiar "closed door" clause used in supplemental agreements equitably adjusting a change order. Once the change is adjusted, the Navy desires no further claims stemming from that change. The clause is invoked and final release obtained, but only when the parties know and can project the change order costs to a reasonable degree of certainty.²⁴

The problem identification clause, like the new changes clause, was drafted to induce a conscientious contractor to report most potential performance problems to the government as they first arise and to stimulate prompt submission of claim information. The stimulus lies in a phrase which has the effect of diminishing the quantum of equitable adjustments by disallowing claim costs incurred more than 20 days before the contractor's submission of the required notice or report.²⁵

In summary, this chapter has focused on the special role of constructive changes in major weapon system acquisition. The nature of constructive changes was examined, as was the rationale for payment of claims resulting from these type changes. The major types of constructive changes were reviewed, and the resultant claims were examined for their relationship to the basic

²⁴Ibid., p. 17..

²⁵Ibid.

change types. Finally, DOD and Navy remedial actions were investigated. It is difficult to determine which remedial action in particular, or if a combination of all these actions, has resulted in the drop-off of constructive change claims shown in Table 17. Whichever the case, the results are impressive.

CHAPTER VI

APPRAISAL OF DOD PROJECT MANAGERS

This chapter will present the opinions of DOD project managers relative to the occurrence of major changes in weapon system production contracts. As was noted in Chapter III, questionnaires were sent to project managers of twenty-one large systems that were in the production stage. In addition, personal interviews were conducted with three additional project managers in an effort to verify or reinforce the data received from the questionnaires. Fourteen questionnaires and three interview responses were received, providing a 70% coverage of the systems selected.

The approach of this chapter will be to first present the project managers' composite definition of major change and their categorization of major change relative to the operations of their projects. Next, the project managers' opinions of the causes of major change will be analyzed, along with any differences in causes reported by the three services. Constructive changes and their causes will then be considered, along with practices found to be effective by project managers to reduce their occurrence. The functioning of configuration management programs will be reviewed, including deficiencies found by the project managers and their recommendations for improvement. Next,

considerations for mandatory pre-pricing of major changes versus "not to exceed" pricing will be examined. Observations of efforts made by prime and/or sub-contractors and by the military departments to better control the occurrence of major change will be examined, and finally the project managers' ideas on ways to resolve or reduce the occurrence of major changes in system production contracts will be enumerated.

As was noted in Chapter I, one of the first problems encountered in this research effort was the development of a clear definition of a "major change" in weapon system production contracts. Project manager respondents were in considerable agreement that a major change was one in which there was a substantial increase or decrease in weapon system capability and/or a change which causes six months or more slippage/stretchout in delivery date. Of the suggested choices (Appendix A), thirteen project managers (about 76%), chose "a substantial increase or decrease in capability" and eleven (or about 65%) chose "six months or more slippage/stretchout."

Other definitions offered by the project manager respondents were: (1) changes over \$5 million, (2) changes over \$10 million, (3) changes where no money is programmed for the change, (4) significant change in a weapon system support concept, (5) any change that requires waiver of a Required Operational Characteristic (ROC), and (6) any change with a high percentage relationship to the total production contract value.

Regarding service differences in the definitions, a majority of Navy project manager respondents chose "Substantial increase or decrease in capability" and "six months or more slippage/stretchout." A majority of Air Force program manager respondents chose a definition of "substantial change in testing requirements," with a high number (three of five) choosing the same definitions as the overall majority. A majority of Army project managers chose definitions of "substantial increase or decrease in capability" and "twelve months or more slippage/stretchout."

In summary, based on the opinion of a majority of all project officer respondents, a major change is a change in which there is a substantial increase or decrease in weapon system capability and/or a change which causes a six months or more slippage/stretchout in delivery date.

With regard to categorization of major changes, the opinion of the project manager respondents was mixed. Seven of the seventeen project managers considered that major change was necessary in a viable weapon system acquisition, while five considered major change to be a major challenge and four felt that major change was a management challenge.

One of the key inquiries to the project managers was for their opinion of the causes of major changes in weapon system production contracts. They were asked to rank suggested causes from 1 to 5 (see question #3, Appendix A). A clear pattern appears regarding the number

choices made for the suggested causes "incomplete plans and specifications at time of award", "changes in program direction/funding (except quantity)", and "changes in operational requirements causing change in weapon systems". Thirteen of the sixteen project managers (about 81%) chose "changes in operational requirements" and eleven of the sixteen (about 69%) chose "incomplete plans and specifications" and "changes in program direction/funding." One project manager's selections could not be utilized in tabulations since he erroneously ranked all suggested causes. The popularity of these three change causes can be seen in the fact that the next most popular change cause was chosen by only seven of sixteen project managers. A complete summary of ranked cause choices selected by the project manager respondents is provided in Table 19.

Regarding causes with many low order/high importance rankings, "incomplete plans and specifications at time of award" had five first rankings and four second rankings. "Changes in operational requirements causing change in weapon system" had five first rankings and two second rankings. The high importance ranking of these two change causes supports their placement in the top three of overall popular change causes selected by the project manager respondents.

The only additional change causes offered by the project managers were: (1) "buy-in" by the contractor, and (2) unknowns identified in engineering and service test programs.

TABLE 19

SUMMARY OF PROJECT MANAGERS' RANKED RESPONSES TO
QUESTION OF CAUSES OF MAJOR CHANGES IN
WEAPON SYSTEM PRODUCTION CONTRACTS

Suggested Causes	Ranking					Total
	1st	2nd	3rd	4th	5th	
a. Accumulation of constructive changes	0	0	1	2	0	3
b. Changes in operational requirements causing change in weapon system	5	2	0	1	5	13
c. Changes in program direction/funding (except qty.)	3	1	3	1	3	11
d. Changes in weapon system to update system to newly achieved state-of-the-art	0	1	1	1	1	4
e. Inability of the contractor to meet the requirements of the contract plans and specifications	0	2	3	2	0	7
f. Inability of the government to accurately estimate actual weapon system cost	0	1	0	2	1	4
g. Incomplete plans and specifications at time of award	5	4	1	1	0	11
h. Inflation	0	1	1	1	0	3
i. Normal engineering and technical changes	0	2	1	0	1	4
j. R&D performed in production contracts	0	0	1	0	1	2
k. Unknowns in production contracts	1	1	2	1	1	6
l. Other	2	1	0	0	0	3

Notes: A few project managers only ranked their first three choices of causes. One project manager ranked all causes and his choices were not utilized.

There were some service differences regarding the opinioned causes of major change. A majority of Navy project manager respondents selected "change in operational requirements" and "incomplete plans and specifications." Air Force program manager respondents generally selected causes identical to those selected by the Navy project manager respondents with the exception that the suggested causes "inability of the contractor to meet the requirements of the contract plans and specifications" and "change in program direction/funding" were given equal consideration. A majority of Army project manager respondents selected the cause "changes in program direction/funding" as their major choice, with "changes in operational requirements" being their secondary choice.

In summary, all project manager respondents believed that: (1) changes in operational requirements causing change in the weapon system, (2) changes in program direction/funding (except quantity), and (3) incomplete plans and specifications at time of award were the causes of major change in weapon system production contracts.

Regarding constructive changes, twelve of the seventeen project managers (about 70%) reported that their projects have not experienced constructive changes. The Navy project manager interviewed felt that constructive change claims were a function of how well financially the contractor performed on the particular production contract. In other

words, if the contract lost money, a constructive change claim would be submitted in order to try to recover some or all of the loss.

For those project managers that had experienced constructive changes, the types most encountered were: (1) drawings were defective in that they contained errors, omissions, inaccuracies or inconsistencies, and (2) specifications or contract provisions were "impossible to perform" because they required work beyond the state-of-the-art or research and development effort.

On this subject, Navy project manager respondents experienced a particular problem with technical direction by persons other than contracting officers in addition to the majority problem of specifications or contract provisions "impossible to perform." A majority of both Air Force and Army project manager respondents agreed with the overall majority as to types of constructive changes encountered.

The practices found to be effective by Navy project manager respondents to control constructive changes are: (1) use of a disclaimer clause in all correspondence with the contractor, (2) routing all correspondence to the contractor via the project management office, and (3) continual reinforcement of constructive change policy by the project manager. The practices found to be effective by the Air Force program manager respondents are: (1) monthly face-to-face meetings between the Air Force program manager and the contractor's program manager to resolve problems,

including change problems, (2) continual reminders of constructive change policy by the program manager, (3) use of not-to-exceed pricing on all changes to encourage speedy and earlier change processing. Practices found effective by Army project manager respondents include: (1) strict configuration control board procedures, (2) policy of not deviating from a good technical package, (3) tight configuration management procedures throughout the project, and (4) strong project policy, guidance and direction concerning constructive changes.

Project managers were next asked to report how the DOD Configuration Management Program was functioning in their projects. Nine of the sixteen project managers utilizing formal configuration management (one Navy project did not utilize formal CM) reported that configuration management was functioning well in their projects. None of the project manager respondents found configuration management to be functioning unsatisfactorily in their projects. Four project managers reported that the program functioned satisfactorily and three reported that the program functioned marginally.

Within the services, opinions on configuration management programs were varied. A majority of Navy project manager respondents reported that configuration management was functioning in a marginal manner in their projects, while a majority of Air Force and Army project manager respondents reported the program functioning well

in their projects. One reason for this variance could be the fact that the U.S. shipbuilding industry is just now establishing viable configuration management programs for government contracts.

A majority of all project manager respondents (nine of sixteen) reported that their projects were meeting the DOD time standards of 24 hours for processing emergency ECP's, 15 days for processing urgent ECP's and 45 days for processing routine ECP's.

While a majority of Air Force and Army project manager respondents reported meeting the DOD processing time standards, three of the five Navy project manager respondents utilizing configuration management reported that the DOD processing time standards are not being met.

The service project manager respondents observed several deficiencies in the DOD Configuration Program and these deficiencies will be presented by service.

Navy project manager respondents reported the following deficiencies: (1) the system is not flexible enough, (2) the program is being implemented by disenchanted contractors and government employees, (3) **there has** been a lack of contractual, funding and administrative tools to fulfill configuration management objectives, (4) participating managers outside the project were not obliged to support the program, especially in the area of processing time standards, and (5) it was difficult to obtain overall

compliance with configuration management directives, especially those applying to processing time standards.

Air Force project manager respondents noted the following deficiencies: (1) there is a lack of configuration responsibility during periods of transition, such as transition from acquisition phase to operational phase, (2) there is a need to reduce the overbearing amount of paper work involved in the configuration program, (3) some supporting organizations are not concerned with processing time standards, and (4) there is need for better definition and delineation of Class I and II changes.

Army project manager respondents reported these deficiencies: (1) the DOD Configuration Management priority system needs revision, (2) there needs to be more emphasis, training and staffing in the configuration management area, and (3) there is presently difficulty in securing the quality and completeness needed in evaluation of engineering change proposals.

Although seven of the project manager respondents did not suggest improvements to the DOD Configuration Management Program, those suggestions from the other ten project manager respondents will be presented.

The recommendations of Navy project manager respondents were: (1) provide project managers with some contractual or funding flexibility for handling small dollar changes, (2) provide contractual vehicles to allow quick correction of deficiencies before the system is delivered, (3) provide

contractual and funding provisions necessary to allow concurrency of coverage for design, engineering and logistic elements when impacted by changes, (4) establish and enforce the use of modification teams to incorporate changes into aircraft and/or equipment instead of allowing the possible false economy of delaying the change till next overhaul of the system, (5) take configuration status accounting out of the hands of the supply (logistic) functions, and (6) do **not** start configuration management until the contractor has achieved a workable prototype.

Air Force program manager respondents' recommendations for configuration management improvements include: (1) establish a clear-cut shift of configuration management responsibility from one command to another at a fixed point in time, (2) attempt to reduce the number of formal steps in configuration management, and (3) place qualified engineers in Air Force Plant Representative Office's (AFPRO) to assist in the processing of engineering change proposals.

The configuration management recommendations from Army project manager respondents were: (1) develop a better method for enforcing compliance with the DOD Configuration Management Program, (2) broaden the scope of configuration management to encompass baseline and engineering change control on provisioning documentation and technical manuals, (3) formally require more emphasis and training for, and staffing in, the configuration management field, (4) recognize the necessity for planning all configuration management

activities in concert with the development program, and (5) establish a new DOD Configuration Management priority system. A new priority system proposed by an Army project manager is found in Appendix K.

Changing emphasis slightly, all project managers were asked to consider the possibility of pre-pricing major changes prior to directing the contractor to perform them. The project managers' responses to this question were so varied that they are considered to be inconclusive. For example, four project managers reported that pre-pricing of major changes could be easily accomplished, while three said it could be done 75% of the time, two felt it could be done 50% of the time, four said it could be done 25% of the time, one said it would be impossible to pre-price major changes, and two project managers advised it depended on other varied circumstances.

Within services, however, the opinions of the Navy project manager respondents were more on the "impossible to pre-price" end of the spectrum than were those of the Air Force or Army project manager respondents.

With regard to the question of possible cost growth and/or system delivery delay if there were a requirement for pre-pricing of all major changes, the project manager respondents were in agreement. Thirteen of the seventeen (about 76%) felt that cost growth and/or system delivery delay would result from mandatory pre-pricing of major changes. Within the services, this same majority opinion held.

In a related question, twelve of the seventeen project managers (about 70%) felt that it would be relatively easy to obtain a ceiling/~~not-to-exceed~~ price for major changes prior to directing the contractor to perform the change. This approach is presently being followed in the Air Force and Army.

Turning to a more important question, the project managers were asked to note any efforts that have been made by prime or sub-contractors that could lead to better control of the occurrence of major changes in weapon system production contracts. Nine of the seventeen project managers reported that they had not observed any change control efforts by prime and/or sub-contractors. In fact, some project managers felt that changes were a "get well" vehicle for contractors having technical or financial problems in the performance of the contract. Contractor change control efforts that were reported will be presented by service.

Navy project manager respondents noted the following contractor efforts: (1) the DOD Configuration Management Program requirement has been contractually impacted upon sub-contractors and vendors, (2) corporate policy was developed to discourage changes, and (3) a formal change review board was established within the company.

Air Force program manager respondents reported these contractor efforts: (1) centralization of management within the company which provides better control of changes, (2) a corporate "no-change" policy, and (3) contractor efforts to move to a "design-to-cost" concept.

Contractor change control efforts reported by Army project manager respondents are: (1) contractors' formal preliminary review of engineering change proposals, (2) contractors' policy of discouraging or refusing changes while a certain number of the system (lot) are in final assembly stage, and (3) contractors' practice of formal review of research and development status and technical data before releasing a system to production.

The above reported contractor efforts and the fact that nine project manager respondents had not observed contractor efforts to control changes will be referred to again in the final chapter of this report.

Project managers were next asked to report efforts made within OSD or the services within the last three years which led to, or could lead to, better control of occurrence of major change. It is interesting to note that five project managers felt that no OSD nor service efforts have been made within the last three years to better control major changes. Considering the fact that the Packard acquisition philosophy, as was spelled out in Department of Defense Directive 5000.1, has been implemented by the services within the last three years, it is assumed that these five project managers were referring to OSD or service efforts that affected their particular project.

Navy project manager respondents reported the following efforts: (1) implementation by the Navy of formal configuration control procedures, (2) implementation

of DOD directive 5000.1, (3) control of major changes through budget/fiscal procedures, and (4) better use of experienced configuration managers.

Air Force program manager respondents observed the following change control efforts: (1) implementation of "fly-before-buy" concept, (2) use of Cost Plus Incentive Fee contracts for development efforts, (3) use of "not-to-exceed" pricing in the issuance of major changes to contractors, (4) exercise of better "risk analysis" prior to production phase decisions, (5) more change control authority provided to program managers, (6) additional change control efforts exercised by program managers, and (7) Air Force program of quarterly Program Assessment Review (PAR) for major weapon systems.

Change control efforts reported by Army project manager respondents were: (1) Army Material Command directive 1000-1 which implements DOD directive 5000.1, (2) a policy that directs that changes will not be considered unless the necessary money for the change is also provided with the change request, (3) establishment of an Army System Acquisition Review Council (ASARC) to review Army programs and program changes prior to their presentation to the Defense System Acquisition Review Council (DSARC), (4) a policy of more testing of systems before they are released for full production, and (5) a new system of dollar ceilings and budget techniques to discourage major changes.

Finally, the project managers were asked to furnish new ideas or concepts which they believed could help reduce/resolve the occurrence of major change in weapon system production contracts. Because of the number of excellent ideas and suggestions, this portion of the chapter will only summarize the most original ideas and those concepts that were concurrently suggested by two or more project managers. A complete listing of all of the project manager respondents' suggestions is provided in Appendix L.

The following ideas or suggestions for reducing/resolving the occurrence of major change in weapon system production contracts are ideas that have previously been discussed by the services, but never formally implemented. **They** are: (1) require earlier program decisions and direction, (2) provide more control to the project managers and reduce pressure for changes from weapon system customers, (3) stabilize weapon system program funding, (4) develop a no-change philosophy, (5) establish an X date after which production would be completed with no further changes, (6) complete all research, development and testing prior to entering production phase, (7) identify problems at an earlier stage in acquisition, (8) use cost type contracts for all development effort, and (9) use prototype contracts for all advanced development efforts.

The following recommendations from the project manager respondents are considered to be particularly novel or original. They are: (1) devise a new method of selling and starting an actual weapon system program without having to oversell the program and promise a performance/cost/schedule package that will not likely happen, (2) establish a system for better control of change money within the applicable service, (3) develop a DOD-wide program for monthly face-to-face meetings between project managers and their contractor counterparts. At these meetings major problems, including change situations, could be discussed and resolved, (4) quarterly review of weapon system programs similar to Air Force Program Assessment Review (PAR). These formal reviews would take place at Air Force Systems Command, Naval Material Command and Army Material Command, (5) develop a system to provide the project managers with more information relative to the make-up of indirect costs associated with major changes, (6) move towards policy of design-to-cost concept for all major weapon systems, (7) develop a program and system requiring the contractor to identify and report the actual cost of changes, and (8) develop a willingness by OSD and the services to accept less than the state-of-the-art product at delivery and to accept some obsolescence in new weapon systems.

These recommendations/ideas will be discussed fully in the concluding chapter.

In summary, this chapter has presented the opinions of military service project managers relative to the occurrence of major changes in weapon system production contracts.

It was first concluded that the project manager respondents defined major change in weapon system production contracts as those causing a substantial increase or decrease in weapon system capability and/or those causing a six month or more slippage/stretchout in delivery date. A majority of the project manager respondents felt that major changes should be categorized as necessary in viable weapon system acquisition programs.

Next, in response to a key question, the project manager respondents reported that the causes of major changes were: (1) changes in operational requirements causing change in the weapon system, (2) change in program direction/funding (except quantity), and/or (3) incomplete plans and specifications at time of award. Both "changes in operational requirements" and "incomplete plans and specifications" were ranked highest in importance of all the suggested or offered causes.

The project manager respondents generally noted that constructive changes were not a problem in the operation of their projects.

Most project manager respondents felt that the DOD Configuration Management Program was functioning well in their projects and a majority of project manager respondents reported that they were meeting the DOD time standards for

processing engineering change proposals. They noted some deficiencies in the present configuration management program and offered various recommendations for the program's improvement.

In another area, the project manager respondents could not come to any agreement as to the extent to which major changes could be pre-priced prior to their acceptance by the contractor, but did strongly agree that a firm pre-pricing requirement for major changes could cause cost growth and/or system delivery delays. Most project manager/respondents agreed that use of ceiling/not-to-exceed pricing on major changes was altogether feasible.

Of a surprising nature, a majority of project manager respondents reported that they have not seen any efforts made on the part of contractors to attempt to control major changes. Some project managers even felt that contractors were using changes to "get well" on their production contracts. The project manager respondents did report, however, many worthwhile efforts made within DOD and the services within the last three years that have or could lead to better control of major changes.

Finally, the project manager respondents provided their own ideas on possible ways to reduce or resolve the occurrence of major change in weapon system production contracts. While some of their ideas were not altogether new, they were very constructive. New and original ideas

were enumerated and will be discussed in more detail in the concluding chapter of this report.

CHAPTER VII
APPRAISAL OF DEFENSE CONTRACTORS

The opinions of defense contractors relative to the occurrence of major changes in weapon system contracts will be presented in this chapter. Questionnaires were sent to the contractor project managers for twenty-two large weapon systems that were in a production stage. Personal interviews were conducted with three additional project managers from industry at their plant locations. Thirteen questionnaires were returned and three interview responses were obtained, providing a 64% coverage of the systems selected.

This chapter will first present the contractors' composite definition of major change and their categorization of major change relative to the operations of their projects. Next, the contractors' opinions as to the causes of major change will be analyzed, along with any differences in causes reported by the contractors to the three services. Constructive changes and their causes will be considered, together with practices that contractors have found effective in reducing their occurrence. The relationship of configuration management programs to major change will be considered, including deficiencies found by contractors and their recommendations for improvements. The possibility of mandatory pre-pricing of major changes versus "not-to-exceed" pricing will then be

examined. Next, observations of efforts made by prime and/or sub-contractors and by the services to better control major change will be examined. Finally, the contractors' ideas on ways to resolve or reduce the occurrence of major change in weapon system production contracts will be reviewed and enumerated.

Regarding the definition of major change, the contractor respondents were in basic agreement that a major change is a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission and/or a change causing twelve months or more slippage/stretchout in delivery date. Of the choices suggested (see Appendix B), eleven of the contractors (about 65%) chose "a substantial increase or decrease in weapon system capability", and nine (about 56%) chose "change in means or method by which the weapon system will perform its mission", "six months or more slippage/stretchout" and "twelve months or more slippage/stretchout".

Other definitions offered by the contractors were: (1) funding constraints which impact procurement, (2) any significant change in system performance, delivery schedule or cost, (3) any contract delivery schedule change either as acceleration or slippage/stretchout of even one month, (4) substantial change in production rate per month as a result of quantity changes, and (5) cost increase of 5% or more.

There were differences of opinion as to the definition of major change among the contractors producing different service projects. A majority of Navy contractor respondents chose "cost change over \$500,000", "cost change over \$1,000,000" and "six months or more slippage". A strong majority of Air Force contractor respondents chose "substantial increase or decrease in capability", while a majority of Army contractor respondents chose "change in means or method by which weapon system will perform its mission", "twelve months or more slippage", and "substantial increase or decrease in capability".

In summary, based on the opinion of a majority of respondents, a major change is a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or a change causing twelve months or more slippage/stretchout in delivery date.

Regarding the categorization of major change, nine of the sixteen contractors (about 56%) considered that major change was necessary in a viable weapon system acquisition.

The contractors were next asked to rank suggested causes of major change and/or suggest other causes. (See question #3, Appendix B). A clear pattern develops concerning four of the suggested causes. Twelve of the sixteen contractors (75%) chose "changes in the weapon system to update the system to a newly achieved state-of-the-art" and "changes in program direction/funding (except quantity)". Also,

eleven of the sixteen (about 69%) chose "changes in operational requirements causing change in the weapon system" and nine of the sixteen (about 56%) chose "R&D performed in production contracts". A complete summary of the contractors' ranked choices is provided in Table 20.

Some cause choices received more low order/high importance rankings. "Change in operational requirements causing change in the weapon system" received four first and three second rankings, while "change in program direction/funding" had three first and three second selections. The high important rankings of these two choices supports their overall top ranking.

The additional major change causes offered by the contractors were: (1) placing weapon systems in production before the complete prove-in and finalization of design, (2) political influence on the direction of a weapon system contract, (3) overlap between design/development and production, (4) deliberate low estimate by a contractor to obtain the contract, (5) time phasing of test programs, and (6) late government furnished equipment.

There were some differences of opinion among respondents regarding the cause of major changes. A majority of Navy contractor respondents selected "change in operational requirements", "change in program direction/funding", and "R&D performed in production contracts". A majority of Air Force contractor respondents selected "change in operational requirements", "change in program

TABLE 20

SUMMARY OF GOVERNMENT CONTRACTORS' RANKED RESPONSES TO
QUESTION OF CAUSES OF MAJOR CHANGES IN
WEAPON SYSTEM PRODUCTION CONTRACTS

Suggested Causes	Ranking					Total
	1st	2nd	3rd	4th	5th	
a. Accumulation of constructive changes	0	1	0	0	0	1
b. Changes in operational requirements causing change in weapon system	4	3	1	2	1	11
c. Changes in program direction/funding (except qty.)	3	3	5	0	1	12
d. Changes in weapon system to update system to newly achieved state-of-the-art	3	1	4	1	3	12
e. Inability of the contractor to meet the requirements of the contract plans and specifications	0	0	0	3	0	3
f. Inability of the government to accurately estimate actual weapon system cost	0	1	2	0	0	3
g. Incomplete plans and specifications at time of award	1	3	0	0	3	7
h. Inflation	1	0	1	0	0	2
i. Normal engineering and technical changes	0	4	0	2	1	7
j. R&D performed in production contracts	1	0	3	3	2	9
k. Unknowns in production contracts	0	0	0	3	0	3
l. Other	3	0	0	0	0	3

direction/funding", and "change in weapon system to update the system to a newly achieved state-of-the-art". A majority of Army contractor respondents chose "change to update system to newly achieved state-of-the-art" and "incomplete plans and specifications at time of award".

In summary, defense contractors that responded to the questionnaire/interviews were of the opinion that: (1) changes in program direction/funding (except quantity), (2) changes in the weapon system to update the system to a newly achieved state-of-the-art, (3) changes in operational requirements causing change in the weapon system, and (4) R&D performed in production contracts were the causes of major changes in weapon system production contracts.

Regarding constructive changes, ten of the sixteen contractors (about 63%) reported that their contracts had experienced constructive changes. The types of constructive changes most frequently reported were: (1) government-provided information, documentation or approvals were late, defective or subsequently revised, and (2) specifications or contract provisions were unclear in that they were open to more than one interpretation or application.

Navy contractor respondents reported the following practices to be effective for them in controlling constructive changes: (1) authorization of work is restricted to the company project manager, (2) all correspondence to contractor is routed through the service project manager and contract administrator, (3) limitations are imposed as

to company personnel who can initiate change, (4) determination of the full cost impact of proposed change, (5) service project manager and contracting officer are advised of prospective change situations by message, and (6) single authority is maintained in the service project office for agreement on work to be performed.

The practices found effective by Air Force contractor respondents were: (1) constructive change control philosophy passed down to sub-contractors, (2) procedures developed for detection and identification of changes at time of performance, (3) claims for constructive changes submitted to government in a timely manner which forces more control by the service project manager, (4) engineering, contracting and finance functions separated within the company.

Practices found effective by Army contractor respondents include: (1) company policy to discourage constructive changes, (2) policy of open working relationship between the contractor's project manager, the service project manager and the service administrative contracting officer, (3) procedure for control of changes to be exercised by one man in the company and one man in the government, (4) company policy of strict configuration management control, (5) arrangement for one formal technical channel between the government and the contractor, and (6) company policy of strict cost authorization controls.

The contractors were asked to report how the DOD Configuration Management Program was functioning in their

programs. Seven of the sixteen contractor respondents (about 44%) reported that configuration management was functioning satisfactorily in their projects, while five found the program functioning well.

The reports of contractor respondents relative to service contracts were varied. Navy contractor respondents found the configuration management program well or satisfactory, while a majority of Air Force contractor respondents reported the program working well. Four of the five Army contractor respondents reported the program functioning satisfactorily.

A majority of contractor respondents reported that the services were not meeting the DOD time standards for processing ECP's. This was particularly true of Navy contractor respondents who all reported that ECP processing times were not being met by the Navy. Air Force contractor respondents, on the other hand, reported that ECP processing time standards were being met by the Air Force, but a majority of Army contractor respondents noted that the processing time standards were not being met by the government on their projects.

Defense contractor respondents observed many deficiencies in the present DOD Configuration Management Program and these deficiencies will be presented by service involvement.

Navy contractor respondents reported the following configuration management program deficiencies: (1) review

cycle and correspondence authority to proceed is too cumbersome, (2) ECP review cycle is too long, (3) procedure lacking for processing government originated ECP's while a weapon system is still in production, (4) time delay and increased cost involved in government review and approval of ECP's, and (5) configuration management not applicable in large systems like ships that are bought one or two at a time.

Air Force contractor respondents noted the following deficiencies in the current configuration program: (1) configuration management program is too cumbersome when applied and adhered to without management review, (2) proliferation of implementing documents exists, (3) configuration management requirements conflict with some other contractual requirements, such as methods and procedures to authorize incorporation of deficiency changes.

The following configuration management deficiencies were observed by Army contractor respondents: (1) ECP cycle is too long, (2) product design freezes are too early, (3) documentation requirements are excessive, (4) configuration management for computer software is not properly prescribed, (5) use of advanced concepts, such as computer aided design, are frequently stifled by configuration management, (6) configuration management program requires configuration inputs during production phase rather than waiting for actual configuration found at time of system shipment, (7) time required to process ECP's is excessive,

(8) level of control of changes by the government is too close and too low, and (9) configuration management does not deal with the problem of conflicting military specifications.

To counter these problems, the contractor respondents offered many recommendations for improvement of the present configuration management program.

Navy contractor respondents offered the following suggestions: (1) keep control of configuration at high enough level to effectively manage, (2) configuration management should not be used on all acquisition programs, (3) configuration management personnel must be in tune with the basic objectives of producing an acceptable product on time and at a reasonable cost, (4) Class II changes should be expanded, (5) formal review only for those changes having a significant effect on cost and performance, (6) procedure should be established for processing government ECP's during production phase, (7) number of people involved in the ECP review cycle should be reduced, (8) service project manager should have more authority to act on proposed changes, and (9) review and approval of ECP's should be accomplished by the service project office rather than by other functional organizations.

Air Force contractor respondents offered the following recommendations: (1) improve the configuration management interface between Air Force Systems Command and Air Force Logistics Command, (2) consolidate many MILSPEC's, a move

which could reduce the number of erroneous interpretations now being made, (3) provide more flexibility to service project managers, and (4) eliminate conflicts and over-management in the present configuration management program.

Army contractor respondents offered the following very worthwhile suggestions for improving the DOD Configuration Management Program: (1) make Defense Contract Administration Services (DCAS) procedures compatible with MIL-STD 480, (2) add a "demonstrated qualification capability" aspect to the configuration management program, (3) gradually increase the degree of configuration control as the individual program matures, (4) reduce constraints on contractors regarding management of no cost changes, (5) provide for local ECP approval during development and early production, (6) freeze design after initial production units are in the field for evaluation, (7) standardize computer software configuration management procedures, and (8) encourage cost saving innovations by providing flexible configuration management procedures where advantageous.

In a different subject area, the defense contractors were asked to consider the possibility of fully pricing all major changes before accepting them from the government. Although their response was varied, six of the sixteen contractors (about 30%) felt that full pre-pricing of major changes was impossible. The reasons they gave for their positions were: (1) contractor must take time to go through his pricing cycle, and this may cause delays which

are undesirable and costly, (2) the contracting cycle for major changes normally takes 9-15 months, thus the later a major change is made the larger the retrofit bill, (3) in order to pre-price major changes, the contractor would have to prepare definitive statements of work, estimates, back-up, a firm proposal, and prepare a cost breakdown DD 633. Audits, negotiations and pre and post negotiation clearances within the government also must be completed, which draws out the time required for full pricing, (4) it could be done only if schedule delay and increased cost are acceptable to the government, (5) large contingency amounts to cover unknowns would be required, and (6) delay in developing and negotiating prices could necessitate slippage of related changes which could result in more costly retrofit.

In answer to a question regarding possible cost growth and/or delivery delay caused by mandatory pre-pricing of all major changes, fifteen of the sixteen contractor respondents advised that cost growth and/or delivery delay would result.

In a related question, seven of the sixteen contractor respondents (about 44%) felt that it would be relatively easy for them to agree on a ceiling/not-to-exceed price for major changes before accepting the change. As was mentioned earlier in Chapter VI, this arrangement is now in effect in the Air Force and Army.

Looking now at a more important question, the defense contractors were asked to report the efforts that their companies have made in the last three years to control the occurrence of major change. It is interesting to consider that in Chapter VI a majority of government project managers noted that they had not observed any efforts on the part of contractors to control the occurrence of major change. The defense contractor respondents, on the other hand, reported a great many efforts that they have made and these efforts will be presented relative to the service involved.

Navy contractor respondents reported that they have taken the following actions during the last three years to control major change: (1) authorization of work within the company is restricted to the applicable program office, (2) prospective commanding officers of ships are required to communicate with the contractor via the applicable administrative contracting officer, (3) contractor's program office reviews all incoming and outgoing correspondence concerning an applicable project, (4) only major changes recommended by the contractor are considered, (5) all critical ground testing is completed at the earliest possible date to minimize the impact of change, (6) contractor established a Program Change Screening Board to weed out any unnecessary changes, (7) company policy that all proposed changes are reviewed carefully as to feasibility and practicability prior to formal implementation, (8) new company policy to minimize change activity following release

of design to production, (9) company fully implemented MIL-STD 480 and the DOD Configuration Management Program, and (10) only quantum increases in performance type changes are recommended to the government for in-production systems.

The change control efforts reported by Air Force contractor respondents were: (1) latest change is sent to beginning of assembly line immediately to reduce the number of in-production changes, (2) major changes are planned and executed more effectively to reduce problems in production, (3) company policy was developed to maintain stability of design, (4) company policy was developed to process only mission essential, operational effectiveness, suitability and mission changes, (5) top level contractor review of proposed changes is held prior to their submittal to the government for consideration, and (6) contractor program manager approves all Class I and II changes.

Army contractor efforts to control the occurrence of major change include: (1) resist major changes through defense project manager and through contractual channels, (2) company policy that proposed changes over \$25,000 must be approved by the company project manager and proposed changes over \$50,000 must be approved by a division manager, (3) available alternatives to major change recommended to the government, (4) company policy to strengthen program management and system engineering aspects of configuration management programs, (5) company policy to strengthen design review and drawing check operations, (6) change approval

system tightened within **the** company, and (7) company implemented management system improvements in such areas as change processing, status reporting and configuration identification.

The defense contractors were next asked to report efforts they had observed made by the services within the last three years which have or could lead to better control of occurrence of major change. Six of the sixteen contractors (about 37%) noted **no government** efforts within the last three years to control major change. Again, for comparison purposes, the contractors' comments on this question will be presented relative to the service involved.

Navy contractor respondents reported the following service efforts that could lead to better control of major change: (1) better control and review of proposed changes is exercised within the services, (2) all proposed changes are formally screened by the services, (3) service project manager is only person allowed to request a change proposal from the contractor, (4) requirements and specifications are more thoroughly drawn, (5) funding limitations and controls have curtailed many unnecessary changes, and (6) strong control of changes is exercised by the service project manager.

The following service efforts in controlling major changes were reported by Air Force contractor respondents: (1) Selected Acquisition Reporting (SAR) identifies and forces early decisions on all **proposed** major changes, (2) services are doing a better job of defining specific

requirements and configuration during early development, (3) more emphasis is now given to cost effectiveness of changes by the service prior to directing change implementation, (4) service policy developed regarding prototype contracting, (5) better service control of changes exercised through control of change money, (6) the services are strictly complying with configuration management procedures, and (7) service policy has been developed to contractually price major changes on a ceiling price basis.

Finally, the defense contractors were asked to suggest new ideas or concepts which could help reduce/resolve the occurrence of major change in weapon system production contracts. As was the case with the response from service project managers, some of the suggestions from contractor respondents were not altogether new, but they were worthwhile. This portion of the chapter will summarize the more worthwhile ideas and the altogether new ideas. A complete listing of the suggestions from all contractor respondents is provided in Appendix M.

The following is a list of routine ideas offered by contractor respondents for reducing/resolving the occurrence of major change in weapon system production contracts: (1) discourage overstatement of requirements and buy only that which is necessary, (2) more recognition to service project managers and less project manager turnover, (3) more simply stated requirements which allow the contractor more flexibility in meeting the requirements,

(4) use of fly-before-buy acquisition policy and prototype contracting, (5) divorce of research, development testing and evaluation from production contracts, (6) encourage early change resolution and expedite change approvals, and (7) exercise restraint in product improvement changes.

The next group of contractor respondent recommendations are considered to be particularly novel or original. They are: (1) efforts must be made to control the engineers involved in weapon system acquisition, since their training has stressed the importance of change for improvement, (2) efforts must be made by the services to stabilize the production rate of major systems by better long-range planning, (3) closer liaison between weapon system user and technical community could result in the inclusion of many mandatory requirements in the original specification, rather than their incorporation by major change, (4) smaller government project management organizations could function better with equally small contractor project organizations, (5) when change money is available it is utilized: some effort must be made to hide change money until it is really needed, (6) consideration should be given to use of the study/review team concept prior to change definition/initiation, (7) freeze design at R&D stage, and (8) develop a new type of weapon system production contract that recognizes the occurrence of major changes and accomodates these type changes more easily and effectively.

These recommendations and ideas will be discussed fully in the concluding chapter.

In summary, this chapter has presented the opinions of defense contractors regarding the occurrence of major changes in weapon system production contracts.

It was initially concluded that the contractor respondents defined major change in weapon system production contracts as a change involving a substantial increase or decrease in weapon system capability, a change in the means or method by which the weapon system will perform its mission and/or changes causing twelve months or more slippage/stretchout in delivery date. A majority of responding contractors felt that major change should be categorized as necessary in viable weapon system acquisition programs.

In response to a key question regarding causes of major change, a majority of contractor respondents chose the following causes: (1) changes in weapon system to update the system to the newly achieved state-of-the-art, (2) changes in program direction/funding (except quantity), (3) changes in operational requirements causing change in the weapon system, and (4) R&D performed in production contracts.

The contractor respondents reported that constructive changes were a problem in the completion of most of their production contracts. Types of constructive changes causing the most problem were: (1) government provided information, documentation or approvals were late, defective or subsequently revised, and (2) specifications or contract provisions

were unclear in that they were open to more than one interpretation or application.

Regarding the functioning of the DOD Configuration Management Program, many of the contractor respondents (44%) reported that the program was only functioning satisfactorily in their projects. A majority reported that DOD time standards for processing ECP's were not being met by the services. They noted some deficiencies in the present configuration management program and offered worthwhile recommendations for the program's improvement.

Concerning the question of pre-pricing all major changes prior to their acceptance of them, the contractor respondents could not agree on the extent to which all major changes could be pre-priced, although 38% felt it would be impossible to ~~pre-price~~ all of them. They did agree that a requirement for pre-pricing major changes could lead to cost growth and delivery delay. Most of the contractor respondents agreed that use of ceiling/not to exceed pricing for major changes was altogether feasible.

The contractor respondents reported their efforts within the last three years to control the occurrence of major change and also made note of service efforts in change control.

Finally, the contractor respondents provided their own ideas of possible ways to reduce or resolve the occurrence of major change in production contracts. While some of their ideas were routine, they were very worthwhile.

Their new and original ideas were enumerated and they will be discussed in the concluding chapter.

CHAPTER VIII

APPRAISAL OF DOD PROCURING AND ADMINISTRATIVE CONTRACTING OFFICERS

The opinions of defense procuring and administrative contracting officers relative to the occurrence of major changes in weapon system contracts will be presented in this chapter. Questionnaires were sent to eighteen procuring contracting officers and twenty-one administrative contracting officers for large weapon systems in the production stage. Personal interviews were conducted with three procuring contracting officers and two administrative contracting officers. Questionnaire/interview responses were received from fifteen procuring contracting officers and seventeen administrative contracting officers, providing a 74% coverage of the systems selected.

Because the two types of contracting officers perform different functions and view the weapon system acquisition process from different positions, an effort will be made to present both their composite opinion and their individual views, especially where these views are substantially different.

This chapter will first present the contracting officer respondents' composite definition of major change and their categorization of major change relative to the

performance of their contracting officer functions. Next, the contracting officers' opinions as to the causes of major change will be reviewed, along with any differences in causes between the reports of the procuring and administrative contracting officer respondents. The effects of constructive changes will be considered, with a special look at possible results from the use of new anti-claims clauses in production contracts. The relationship of configuration management to major change will be considered, including deficiencies in the program found by administrative contracting officer respondents and their recommendations for improvement. The feasibility of mandatory pre-pricing of major changes will be considered, along with a secondary consideration of "not-to-exceed pricing" for major changes. Next, efforts made by contractors and the services to control occurrence of major change will be examined. Finally, the ideas of the procuring and administrative contracting officer respondents for resolving or reducing the occurrence of major changes will be enumerated.

Regarding the definition of major change, the contracting officer respondents were in agreement that major change is a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or six months or more slippage/stretchout in delivery date. Of the choices suggested, twenty-seven of the contracting officer respondents (about 84%) chose "a substantial increase or decrease in weapon system capability",

twenty-five (about 80%) chose "change in means or method by which system will perform its mission", and twenty-two (about 70%) chose "six months or more slippage/stretchout".

The procuring and administrative contracting officer respondents did have differing opinions on the degree of delivery delay, with a majority of procuring contracting officer respondents selecting twelve months delay, while a majority of administrative contracting officer respondents chose six months delay.

Other definitions offered by the contracting officer respondents were: (1) changes involving 1% or more of non-recurring costs, (2) significant change in support philosophy, such as contractor to government or depot to field, (3) program changes as directed by Congress through Authorization and Appropriation Bills, (4) any change stopping the production line, (5) substantial change in quantity requirements, (6) substantial change in configuration not related to capability, (7) change in source of major components, and (8) change in type of contract.

In summary, based on the opinion of a majority of defense contracting officer respondents, a major change is a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or a change causing six months or more slippage/stretchout in delivery date.

With regards to the categorization of major change, a majority of defense contracting officer respondents decided that major change was necessary in a viable weapon system production contract.

In a key question, defense contracting officers were asked to rank suggested causes of major change and/or suggest other causes (See question #3, Appendices C and D). Of the twenty-nine contracting officers responding to this question, twenty-one (72%) chose "change in the weapon system to update the system to newly achieved state-of-the-art", twenty (about 70%) chose "incomplete plans and specifications", nineteen (about 66%) chose "changes in operational requirements causing change in weapon system", and fifteen (about 52%) chose "change in program direction/funding (except quantity)". A complete summary of the contracting officers' ranked choices is provided in Table 21.

There were some differences of opinion between procuring and administrative contracting officer respondents regarding the causes of major changes. While both groups agreed on "change to update system" and "incomplete plans and specifications", a majority of procuring contracting officer respondents favored the cause "changes in operational requirements", while a majority of administrative contracting officer respondents favored the cause "changes in program direction/funding" and "R&D performed in production contracts".

Some suggested causes received a majority of low order/high importance rankings. "Changes in operational

TABLE 21

SUMMARY OF DEFENSE PROCURING AND ADMINISTRATIVE CONTRACTING
OFFICERS' RANKED RESPONSES TO QUESTION OF CAUSES OF
MAJOR CHANGES IN WEAPON SYSTEM PRODUCTION CONTRACTS

Suggested Causes	Ranking					Total
	1st	2nd	3rd	4th	5th	
a. Accumulation of constructive changes	0	1	2	0	4	7
b. Changes in operational requirements causing change in weapon system	7	4	5	3	0	19
c. Changes in program direction/funding (except qty.)	2	5	0	4	4	15
d. Changes in weapon system to update system to newly achieved state-of-the-art	4	5	8	2	2	21
e. Inability of the contractor to meet the requirements of the contract plans and specifications	2	2	0	4	3	11
f. Inability of the government to accurately estimate actual weapon system cost	0	2	3	1	1	7
g. Incomplete plans and specifications at time of award	7	3	4	4	2	20
h. Inflation	0	0	1	1	2	4
i. Normal engineering and technical changes	2	1	2	2	3	10
j. R&D performed in production contracts	4	4	2	2	2	14
k. Unknowns in production contracts	0	2	1	2	1	6
l. Other	1	0	1	0	0	2

requirement" received eleven first and second choice rankings, "incomplete plans and specifications" received ten first and second choice rankings, "change to update system" received nine first and second choice rankings, and "R&D performed in production contracts" received eight first and second choice rankings.

On the opposite end of the spectrum, "changes in program direction" had eight fourth and fifth choice rankings and "inability of the contractor to meet the requirements of the contracts" had seven fourth and fifth choice rankings.

In summary, defense contracting officers responding to study questionnaire/interviews were of the majority opinions that the causes of major changes in weapon system production contracts were changes to update the system to newly achieved state-of-the-art, incomplete plans and specifications at time of award, changes in operational requirements causing change in the weapon system, and/or changes in program direction/funding (except quantity).

Regarding constructive changes, seventeen of the contracting officer respondents (about 57%) felt that the weapon system production contracts that they had awarded/administered had not experienced constructive changes. It is interesting to note that while a majority of procuring contracting officer respondents did express problems with constructive changes, a majority of the administrative contracting officer respondents, located at the plant, did not note problems with constructive changes.

The types of constructive changes that were a problem to the contracting officer respondents were "specifications or contract provisions which were unclear in that they were open to more than one interpretation or application" and "technical direction by persons other than contracting officers".

In a separate question, the procuring contracting officers were asked to consider to what extent the anti-claims clauses currently being utilized by the Navy in weapon system contracts could alleviate the problem of constructive changes in weapon system production contracts. Because a majority of the procuring officer respondents were unfamiliar with the Navy anti-claim clauses, a majority opinion on that question could not be obtained. The response from Navy procuring contracting officers who were familiar with the anti-claims clauses was so varied as to be inconclusive.

The administrative contracting officers were asked how the DOD Configuration Management Program was functioning relative to the weapon system production contract which they were administering. Nine of the sixteen administrative contracting officer respondents (about 53%) reported that the program was functioning satisfactorily, with the balance split about even between an evaluation of well and marginal.

In reply to a question of whether or not the government was meeting the DOD time standards for processing ECP's,

the seventeen administrative contracting officer respondents were split about even on whether or not the government was meeting the time standards.

Next, the administrative contracting officers were asked to report any deficiencies they found in the present DOD Configuration Management Program.

Navy administrative contracting officer respondents reported the following deficiencies: (1) the configuration management system needs to be more responsive during the production phase, (2) the government is moving the responsibility for technical publications from contract to in-house, and this could have an impact on coordination of configuration management, (3) there is no serious attempt to freeze configuration at any logical point because of desire to have the latest developments incorporated immediately, (4) processing time for routine ECP's is excessive, (5) configuration board functions on the basis of "nice to have" and fund availability rather than need, and (6) contractors are forced to tailor their production system to requirements of configuration management.

Air Force administrative contracting officer respondents reported only two deficiencies in the present configuration management program. They were: (1) coordinating cycle for changes is so complex that by the time the initiator of the change notifies everyone involved, he has forgotten why he wanted the change, and (2) the Air Force Plant Representative, in many cases, is not involved

in the details of performance of the configuration management program.

Army administrative contracting officer respondents also had two deficiencies to report. They were: (1) approval of Class II engineering changes are not always delegated to the Defense Contract Administrative Services, resulting in extraordinary time processing, and (2) there is a problem of control of interface between government furnished equipment and contractor hardware.

The administrative contracting officers were next asked to recommend improvements in the DOD Configuration Management Program.

Navy administrative contracting officer respondents offered the following five recommendations: (1) some authority to approve ECP's must be delegated to the field, (2) pre-determined "blocks" or "lots" of each weapon system should be produced with a set configuration and no changes allowed in that block, (3) ECP's should be processed faster, (4) changes to weapon systems should be limited to safety and mission accomplishment, and (5) the configuration management program should operate on the basis of milestones or goals.

Only one recommendation was offered by Air Force administrative contracting officer respondents. It concerned the position that notification of change to "other" activities should be after the fact, on a for-information-only basis.

Two Army configuration management recommendations were also received. They concerned giving one contractor total configuration management responsibility and the requirement for pricing changes prior to directing contractors to perform them.

In a new subject area, the defense contracting officers were asked to consider the possibility of fully pricing all major changes prior to directing the contractor to perform them. The response to this question was varied. Twelve of the contracting officer respondents (about 40%) felt that full pre-pricing of major changes was impossible. Six respondents felt pre-pricing could be accomplished 25% of the time, and seven felt it could be done on 75% of all major changes. There were no marked differences of opinion between the procuring and administrative contracting officer respondents on that question.

The defense contracting officer respondents were very clear in their opinion on whether mandatory pre-pricing of major changes could cause cost growth and/or delivery delay. Thirty of the thirty-two contracting officer respondents (about 94%) felt that mandatory pre-pricing could cause cost growth and/or delivery delay.

In answer to a related question, a majority of the contracting officer respondents believed that the establishment of a ceiling/not-to-exceed price on major changes could be easily accomplished. It is interesting to note that only the Navy procuring and administrative contracting

officer respondents did not agree with this majority opinion. As was mentioned earlier in Chapters VI and VII, ceiling prices for changes ~~are~~ presently an Army and Air Force requirement.

On the subject of efforts made on the part of contractors to control the occurrence of major change, eighteen of the thirty-two contracting officer respondents (about 53%) reported that they had not observed any contractor change control efforts. This response compares almost exactly with that of the defense project managers, where 53% noted no contractor efforts to control the occurrence of major change.

The observations of those contracting officer respondents that did note contractor change control efforts will be presented by service for comparison purposes.

Contractor change control efforts reported by Navy contracting officer respondents include: (1) contractor efforts to control change made or suggested by sub-contractors, (2) company top management commitment to change control, and (3) contractor policy to discourage changes.

Air Force contracting officer respondents reported the following contractor change control efforts: (1) better task definition by contractor, (2) contractor in-depth periodic progress reviews, (3) company value engineering program which relates to ECP's, (4) high management attention placed on control of changes, and (5) practice of prime contractor placing his own engineers in sub-contractor's plant to review possible changes.

Contractor change control efforts reported by Army contracting officer respondents include: (1) effective change control management job is being done by the contractor, (2) contractors are accepting ceiling prices on major changes, (3) contractor has established an ad hoc engineering group to monitor and control all engineering changes, (4) contractors have attempted to complete all R&D efforts before production phase begins, (5) contractor has integrated production planning during design phase, and (6) contractor maintains a close relationship with service project manager to resolve pending problems.

The contracting officers were next asked to report efforts that they had observed made by the services during the last three years that have or could lead to better control of occurrence of major change. For comparison purposes, these reports will be presented by type of contracting officer and by service.

Navy procuring contracting officer respondents reported the following service efforts to control major change: (1) fly-before-buy acquisition policy, (2) movement away from "total package" procurement, (3) new contractual language which makes changes financially unrewarding for the contractor, (4) refusal by government engineers and contracting officers to accept ECP's which do not increase capability of the system, (5) implementation of DOD Directive 5000.1 acquisition policies, (6) configuration control boards and change control procedures implemented

by Naval Systems Commands, (7) Chief of Naval Material directives discouraging issuance of major changes without pre-pricing, (8) budget efforts on the part of ship acquisition project managers to control change money, (9) greater concern by project managers relative to control of major changes, (10) better contracts for major weapon system acquisitions, and (11) final pricing of major changes prior to approval and issuance.

Service change control efforts reported by Air Force procuring contracting officer respondents include: (1) service project manager must justify all unilateral changes, (2) Saturday morning briefings of the Assistant Secretary of Defense (Installation and Logistics) by service project managers are held, (3) new contract clauses which assure less fee and/or ceiling on fixed price incentive contracts for changes have been developed, which results in the contractor resisting changes, (4) there is a movement away from concurrent R&D and production, (5) services directed use of not-to-exceed pricing on major changes, and (6) DOD Directive 5000.1 on acquisition policy was implemented.

Army procuring contracting officer respondents reported the following three service change control efforts: (1) change to Armed Service Procurement Regulations which requires more detailed review of cost estimates prior to implementing change, (2) monthly face-to-face meetings between contractor and service project managers, and (3) ceiling prices utilized on major changes.

Looking at service change control efforts from a different vantage point, Navy administrative contracting officer respondents reported the following service efforts: (1) use of the fly-before-buy acquisition concept, (2) strong control on out-of-scope technical direction exerted by project managers, (3) practice of pre-pricing changes and utilization of not-to-exceed pricing, and (4) policy of ECP's being rejected because of cost aspects.

Air Force administrative contracting officer respondents noted the following change control efforts: (1) major changes are now reviewed prior to issuance, (2) approval level for change raised by the service, (3) utilization of design to cost concept in acquisition, (4) use of prototype concept, (5) termination of heretofore "essential" parts of a program, (6) program discipline exercised through change boards, and (7) development of second sources for major items.

Army administrative contracting officers also observed some interesting service efforts in change control. They were: (1) utilization of not-to-exceed pricing for changes, (2) implementation of DOD system for contractor systems for cost and schedule control, (3) use of fly-before-buy concept in acquisition, (4) implementation of DOD Directive 5000.1 Packard acquisition policy, (5) elimination of total package procurement, (6) utilization of frequent meetings between the Defense Contract Administration Service and procuring engineers to evaluate ECP's,

and (7) use of on-site technical representatives to expedite ECP's.

Finally, the contracting officers were asked to suggest new ideas or concepts which could help reduce/resolve the occurrence of major change in weapon system production contracts. As was the case with service and contractor project managers, some of the suggestions or ideas were not altogether new, but were very worthwhile. Because of the number of suggestions/ideas submitted, this portion of the chapter will only present altogether new ideas. A complete listing of all suggestions/ideas from defense contracting officer respondents is provided in Appendix N.

The following new/original ideas were submitted by the contracting officers: (1) consider only flight safety changes in aircraft; all other changes would be made in the next year buy, (2) do away with the present Armed Services Procurement Regulations change clause, (3) consider front-end costing of lead ships on a cost-plus-fixed-fee or cost-plus-incentive-fee basis, (4) utilize DOD Directive 7000.2 and budget changes based on work packages, (5) develop a system to control change money, (6) change disbursement arrangements for contracts to "pay as you go" which will encourage contractors to price changes faster, (7) reward defense project managers for their ability to control changes as well as the technical and operational capabilities of the weapon system, (8) try to stabilize redirection of

programs due to money problems, (9) allow time in the production schedules for change impacts, (10) require user/customers to fund changes they request, (11) provide for an assistant project manager for business management who would have equal voice with technical types in the evaluation of proposed changes, (12) learn to live with major changes; the cheapest and least disruptive change is one that is resolved prior to the start of changed work, (13) develop a "will cost" approach to major changes, (14) consider a change in contract type for major weapon system production contracts, such as cost-plus-award fee in lieu of fixed-price-incentive, (15) utilize "Truth in Negotiations" Public Law 87-653 for major changes and require that the contractor provide factual data on changes, (16) develop ways to reward contractors for more worthwhile ECP's, (17) increase use of pre-production and prototyping for proven and low-risk concepts, (18) have service project managers approve every change personally, (19) delete the Armed Services Procurement Regulations change clause and require a new contract for each out-of-scope new requirement, and (20) consider model contract experimentation for major weapon system acquisition.

These recommendations and ideas will be discussed fully in the concluding chapter of this report.

In summary, this chapter has presented the opinions of defense contracting officers regarding the occurrence of major changes in weapon system production contracts.

It was initially concluded that the contracting officer respondents defined major change as a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or a change causing six months or more slippage/stretchout in delivery date. A majority of responding contracting officers felt that major changes could be categorized as necessary in viable weapon system production contracts.

In response to an important question regarding the causes of major changes, a majority of contracting officer respondents chose the following causes: (1) change in the weapon system to update the system, (2) incomplete plans and specifications, (3) changes in operational requirements causing change in the weapon system, and/or (4) changes in program direction/funding (except quantity).

A majority of the contracting officer respondents reported that their weapon system production contracts had not experienced constructive changes. For those contracting officer respondents that had problems with constructive changes, the types experienced most were specifications or contract provisions which were unclear in that they were open to more than one interpretation or application and the problem of technical direction by persons other than the contracting officer.

Regarding the operation of the DOD Configuration Management Program, a majority of administrative contracting

officer respondents reported that the program was functioning satisfactorily for the production contracts that they were administering. They were split about even regarding a question concerning whether the government was meeting the DOD processing time standards for ECP's. The administrative contracting officer respondents reported a few deficiencies in the configuration management program and furnished some worthwhile recommendations for the program's improvement.

Concerning the question of pre-pricing all major changes prior to directing the contractor to perform them, the opinions of the contracting officer respondents were not conclusive. About 40% of the respondents felt that mandatory pre-pricing was impossible and the balance were split between "easily done" and "possible on 25% of changes". An overwhelming majority of the contracting officer respondents did feel that mandatory pre-pricing of major changes could lead to cost growth and/or delivery delay. They were also in agreement that not-to-exceed/ceiling pricing on major changes could be easily accomplished.

The contracting officer respondents noted contractor efforts that could lead to control of occurrence of major change and also reported like government efforts.

Finally, the contracting officer respondents provided their own ideas of possible ways to reduce or resolve the occurrence of major change in weapon system production contracts. New and original ideas were enumerated and will be discussed in the concluding chapter.

CHAPTER IX

SUMMARY, CONCLUSIONS AND SUGGESTIONS

This chapter will present a summary of the report, state answers to the research questions, develop conclusions, set forth suggestions for consideration by the government and the defense industry and, finally, suggest additional research.

Chapter I introduced the report. Control of major changes to weapon system acquisition contracts was presented as the subject of the study. The purpose of the research was set forth as: (1) acquisition of primary data concerning the causes of major changes to weapon system production contracts, (2) investigation of action taken by the government and contractors to control the occurrence of major changes, and (3) discovery of new and original ideas or approaches for better controlling major change. The significance of the research noted was that primary data concerning the root causes of major changes had never been documented. Different points of view concerning major change and resultant cost growth were presented. It was reported that, to Congress, cost growth represents expenditures of funds which were neither authorized nor appropriated. For the Department of Defense, major changes and cost growth were seen as possibly leading to cancellation of programs

important to the defense of the country. For the defense industry, major changes and resultant cost growth were seen as jeopardizing major productive efforts and possibly shaking the financial structure of companies. For taxpayers, cost growth was seen as a cause for increased taxes, increased national debt or transfer of funds from socially-oriented programs to defense-oriented programs. The four objectives of the research reported in Chapter I were:

- (1) acquisition of data on the causes of major changes,
- (2) acquisition of new and original ideas for resolving or reducing the occurrence of major changes, (3) comparison of the opinions of the principals involved in major change, and (4) rekindling the interest of the Department of Defense in the problems of major changes. The research and subsidiary questions were presented and the limitations of the research were set forth. The basic limitations were:

- (1) only systems in a production phase with a program value of over \$300 million were studied, (2) only the opinions of the four change principals were obtained, (3) the interview and questionnaire processes were conducted under conditions of anonymity, and (4) only unclassified data was utilized.

Certain special terms were defined and Chapter I closed with a presentation of the organization of the report.

Background on the problem of control of major changes to weapon system acquisition contracts was presented in Chapter II. First, a review of the literature was conducted, which included important academic and governmental research

on the subject of changes and cost growth. Most noteworthy were the dissertations of Richard Lorette and James Reece. These reports presented empirical data obtained from research into the relationship of changes to the operation of program management offices and the relationship of the number and dollar value of changes to the contractor's loss of program cost control. The scope of the problem was analyzed. A report from the General Accounting Office was presented which showed that at the end of fiscal year 1971, forty-six weapon systems had experienced \$18.7 billion in changes other than quantity. It was shown from a 1972 Department of Defense report that 771 change orders, or 10.4% of all change orders issued in fiscal year 1972, represented \$1.2 billion or 82.9% of total change order dollar expenditures. It was also shown that 713 additional work modifications, or 5% of the additional work modifications issued in fiscal year 1972, represented \$5.2 billion or 80.6% of the total additional work dollar expenditures. Finally, prior efforts to control contract changes were reviewed. Most noteworthy were those of the Office of the Secretary of Defense on prototyping, the Navy's constructive change and unpriced change order control efforts, the Air Force's improved contractual features and the Army's PROMAP-70 program.

Research methodology was presented in Chapter III. The research approach described was the development of empirical data by querying the principals involved in approving, directing, accepting and performing major changes.

The principals identified were the government's project manager, the contractor's project manager, and the government's procuring and administrative contracting officers. The formulation of interview questions and development of the questionnaire were described and the sample design was explained. Questionnaires were sent to the change principals of twenty-two large weapon systems that were in a production phase, and interviews were conducted with the change principals involved in one producing system from each service. The advantages noted for using this sample were: (1) all services represented, (2) all types of weapon systems represented, (3) all types of defense industries represented, and (4) the twenty-five systems were produced in scattered areas of the country. It was noted that letters of introduction from Deputy Assistant Secretary of Defense (Procurement) J.M. Malloy were provided to all interviewees and to those receiving a questionnaire. The analysis of the data was explained and the limitations of the research methodology were set forth.

Chapter IV focused on the relationship of configuration management to the overall problem of major changes in weapon system production contracts. The Department of Defense Configuration Management Program was described. It was shown that the four essential functions of configuration management are: (1) identification and documentation, (2) audit, (3) status accounting, and

(4) change control. It was shown that the engineering change proposal was the tool through which the change control program operates. The types of engineering change proposals (ECP's) delineated were: (1) correction of deficiency, (2) improvement change, (3) state-of-the-art advance, (4) value engineering change, (5) optional accessory change, and (6) "gold-plating" changes. The classes and priorities of engineering change proposals were described. It was noted that a decision on emergency ECP's must be made within 24 hours of receipt, within fifteen days of receipt on urgent ECP's, and within forty-five days for routine ECP's. The operation of configuration management within the services was described, including flow charts showing organization relationships. It was noted that the Navy's procedure for processing engineering change proposals was quite cumbersome. Configuration management problems being experienced by the services were reviewed, including the Navy's problems with processing times and anti-claims clauses, the Army's problems with implementing the prototype concept which delays start of formal configuration management, and the Air Force's problems with intercommand responsibilities for configuration management. It was concluded that the Department of Defense Configuration Management Program forces the services to provide intelligent and efficient evaluation of engineering changes proposed either by the contractor or by the services themselves.

Chapter V focused on the special role of constructive changes to weapon system production contracts. A constructive change was defined as any conduct by a government representative which is not supported by a formal change order, but which has the effect of requiring the contractor to perform work different from that prescribed by the original terms and conditions of the contract. The types of constructive changes described were: (1) specifications and contract provisions impossible to perform because they require work beyond the state-of-the-art, (2) specifications or contract provisions which were impossible to perform or defective because of conflicting or erroneous requirements, (3) specifications or contract provisions which are unclear or open to more than one interpretation, (4) drawings defective in that they contained errors, (5) government provided information or documentation that was late or defective, (6) work accelerated, (7) improper rejection of work, and (8) technical direction by personnel other than contracting officers. It was shown that at the end of December, 1972, the Navy had an inventory of over \$1 billion in claims for alleged constructive changes. Navy efforts to resolve the constructive change problem were reviewed. They included: (1) training in constructive change recognition, (2) improving preparation of specifications, (3) in process verification and review of technical data, and (4) claims identification clauses developed and utilized in large weapon system development and production contracts. Finally,

it was shown that as a result of these efforts no claims for alleged constructive changes were received by the Navy during the first three months of 1973.

The opinion of government project managers relative to the occurrence of major changes in weapon system production contracts was presented in Chapter VI. The project manager respondents defined major change as one in which there was a substantial increase or decrease in weapon system capability and/or a change which causes six months or more slippage/stretchout in delivery date. A majority of the project manager respondents felt that major change should be categorized as necessary in viable weapon system acquisition programs. Next, in response to a key question, the project manager respondents reported that the cause of major changes were: (1) changes in operational requirements causing change in the weapon system, (2) change in program direction/funding (except quantity), and/or (3) incomplete plans and specifications at time of contract award. The project manager respondents noted that constructive changes were not a problem in the operation of most of their projects and they strongly agreed that a mandatory pre-pricing requirement for major changes could cause cost growth and/or system delivery delay. The project manager respondents noted deficiencies in the Department of Defense Configuration Management Program and offered suggestions for improvements to the program. They reported efforts made by the services and contractors to control the occurrence of major changes

and offered new ideas for reducing or resolving the problem. Some of their more original ideas were: (1) devise a new method for selling and starting an actual weapon system program without having to "oversell" the program and promise a performance/cost/schedule package that will not likely happen, (2) establish a system for better control of change money within the applicable services, (3) move towards a policy of design-to-cost for all major weapon systems, and (4) develop a willingness by the services to accept less than the state-of-the-art product at delivery and accept some obsolescence in new weapon systems.

Chapter VII presented the opinions of defense contractors relative to the occurrence of major changes in weapon system production contracts. The contractor respondents defined major change as a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission and/or a change causing twelve months or more slippage/stretchout in delivery date. Like government project manager respondents, the contractor respondents felt that major change was necessary in a viable weapon system acquisition. A majority of contractor respondents felt that the causes of major changes were: (1) changes in program direction/funding (except quantity), (2) changes in the weapon system to update the system to a newly achieved state-of-the-art, (3) changes in operational requirements causing change in the weapon system, and

(4) research and development performed in production contracts. A majority of contractor respondents felt that their contracts had experienced constructive changes and reported that configuration management was functioning well in their programs. They noted deficiencies in the present configuration management program and offered suggestions for improvement. The contractor respondents were also of the opinion that mandatory pre-pricing of major changes could lead to cost growth and/or system delivery delay. Efforts they had made to control changes were pointed out and government change control efforts they had observed were presented. Finally, some of the new ideas offered by the contractor respondents for controlling major changes were presented: (1) efforts must be made to control the engineers involved in weapon system acquisition since their training stressed the importance of change for improvement, (2) closer liaison between the weapon system user and the technical community could result in the inclusion of many mandatory requirements in the original specifications, (3) when change money is available it is utilized; therefore some efforts must be made to hide change money until it is really needed, and (4) develop a new type of weapon system production contract that recognizes the occurrence of major changes, and accomodates these type changes more easily and effectively.

Chapter VIII presented the opinions of defense procuring and administrative contracting officers relative

to the occurrence of major changes in weapon system production contracts. Regarding the definition of major change, the contracting officer respondents were in agreement that major change is a change involving a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or six months or more slippage/stretchout in system delivery date. A majority of the contracting officer respondents felt that major change should be categorized as necessary in a viable weapon system acquisition. The causes of major change in weapon system production contracts as reported by a majority of the defense contracting officer respondents were: (1) changes to update the system to a newly achieved state-of-the-art, (2) incomplete plans and specifications at time of award, (3) changes in operational requirements causing changes in the weapon system, and (4) changes in program direction/funding (except quantity). A majority of the contracting officer respondents felt that the contracts they had awarded/administered had not experienced constructive changes. Also, a majority of defense contracting officer respondents reported that the Department of Defense Configuration Management Program was functioning satisfactorily. They reported deficiencies in the configuration management program and offered suggestions for its improvement. The defense contracting officer respondents felt strongly that a mandatory requirement for pre-pricing

major changes could lead to cost growth and/or system delivery delay. They noted efforts made on the part of the government to control changes, but reported few contractor change control efforts. The defense contracting officer respondents offered the following new or original ideas for resolving or reducing the occurrence of major changes: (1) consider only flight safety changes in aircraft, with all other changes in the next year buy, (2) develop a system to control change money, (3) allow time in production schedules for change impacts, (4) learn to live with major changes, considering that the cheapest and least disruptive change is one that is resolved prior to the start of changed work, and (5) consider model contract experimentation for weapon system acquisition.

With the summary completed, answers to the research and subsidiary questions will now be presented, with the subsidiary questions answered first.

1. What constitutes a "major" change to weapon system production contracts?

A major change to a weapon systems acquisition contract is one in which there is a substantial increase or decrease in weapon system capability, a change in means or method by which the weapon system will perform its mission, and/or a six month or more slippage/stretchout in the delivery date for the system.

2. What are the objectives of the Department of Defense Configuration Management Program, especially as the program relates to change control?

The objectives of the Department of Defense Configuration Management Program are: (1) to assist management in achieving, at the lowest

sound cost, the required performance, operational efficiency, logistic support and readiness of configuration items, (2) to allow the maximum degree of design and development latitude, yet introducing at the appropriate time and degree, the depth of configuration control necessary for production and logistics support, (3) to attain maximum efficiency in the management of configuration changes with respect to their necessity, cost, timing and implementation, and (4) to obtain the optimum degree of uniformity in configuration management policy, procedures, data, forms and reports at all interfaces within the services and between the services and industry.¹

3. What efforts have been made by the Department of Defense within the last three years to control changes to weapon system acquisition contracts?

Efforts made by the Department of Defense within the last three years to control the occurrence of changes in weapon system acquisition contracts include:

(1) acquisition policy of design-to-cost, (2) acquisition policy of prototyping in advanced development, (3) policy requiring ceiling prices on all change orders to weapon system contracts, (4) requirement that changes with a production cost of over \$100 million be approved by the Office of the Secretary of Defense, (5) use of new anti-claims clauses in weapon system contracts, (6) use of clauses in weapon system contracts which preclude pricing changes that are beneath a certain dollar ceiling, (7) use of Cost-Plus-Fixed-Fee contracts for development efforts, which reduces the contractor's need to "get-well" on production contracts, (8) exercise of better risk analysis by the Defense System Acquisition Review Council (DSARC) prior to making production phase decisions, (9) formal screening of all proposed changes through project Configuration Change Boards, and (10) widening the implementation of the Department of Defense Configuration Management Program to the shipbuilding industry.

4. What efforts have been made by the defense industry within the last three years to control changes in weapon system acquisition contracts?

¹Department of Defense. Configuration Management, Department of Defense Directive 5010.19. (Washington, D.C.: Government Printing Office, July 17, 1968), pp. 2-3.

While a majority of government respondents noted little contractor efforts to control changes, the following efforts were reported by contractor respondents: (1) company policy developed that required that proposed changes over \$25,000 must be approved by the company's project manager and proposed changes over \$50,000 must be approved by an applicable division director, (2) company resistance to major changes through defense project manager and contractual channels, (3) available alternatives to major change recommended to the government, (4) company policy to strengthen design review and drawing check operations, and (5) company implemented management system improvements in such areas as change processing, status reporting and configuration identification.

5. In major changes to weapon system contracts, what is the relationship of constructive to formal changes?

A review of constructive change claims settled by the Navy and the Armed Services Board of Contract Appeals between 1964 and 1969 showed that about 42% of the initial claim amounts were paid. Using this 42% ratio to the \$1,008 million in outstanding constructive change claims in the Navy in December, 1972, as much as \$423 million could be paid to contractors for constructive changes. This figure of \$423 million in possible constructive changes is 5.3% of the \$7,907 million of contract modifications issued by the Department of Defense in fiscal year 1972 covering change orders and additional work. Therefore, it is roughly concluded that constructive changes represent about 5% of formal changes.²

6. In the view of defense contractors, what recognizable variables induce major changes to weapon system contracts?

Defense contractor respondents were of the majority opinion that the following variables were the cause of major changes to weapon system production contracts: (1) incomplete plans and specifications at time of award, (2) changes in program direction/funding (except quantity), and (3) changes in operational requirements causing change in the weapon system, and (4) research and development performed in production contracts.

²Department of Defense. Office of the General Counsel of the Navy. Memorandum dated August 6, 1969, TAB A.

7. In the view of defense project managers, what recognizable variables induce major changes to weapon system contracts?

Defense contractor respondents were of the majority opinion that the following variables were the cause of major changes to weapon system contracts: (1) incomplete plans and specifications at time of award, (2) changes in program direction/funding (except quantity), and (3) changes in operational requirements causing change in the weapon system.

8. In the view of government procuring and administrative contracting officers, what recognizable variables induce major changes to weapon system contracts?

Defense contracting officer respondents were of the **majority** opinion that the following variables were the cause of major changes in weapon system contracts: (1) change in the weapon system to update the system to newly achieved state-of-the-art, (2) incomplete plans and specifications at time of award, (3) change in operational requirements causing change in the weapon system, and (4) changes in program direction/funding (except quantity).

9. What new and unusual efforts might be attempted by the defense industry and the government to control major changes to weapon system contracts?

Some of the more original ideas offered by the change principal respondents for controlling the occurrence of major changes in weapon system production contracts were: (1) devise a new method for selling and starting an actual weapon system program without having to oversell the program and promise a performance/cost/schedule package that will not likely happen, (2) establish a system for better control of change money within the applicable services, (3) develop a willingness by the services to accept less than the state-of-the-art product at delivery and accept some obsolescence in new weapon systems, (4) control engineers involved in weapon system acquisition, since their training stressed the importance of change for improvement, (5) develop closer liaison between the weapon system user and the technical community in order that more mandatory requirements can be included in the original specification, (6) develop a new type of weapon system production contract that would recognize the occurrence of major changes and accomodate those

types of changes more easily and effectively, (7) consider only flight safety changes in aircraft, with all other changes in the next year buy, (8) allow time in the production schedule for change impacts, and (9) learn to live with major change, considering that the cheapest and least disruptive change is one that is resolved prior to the start of work.

RESEARCH QUESTION - What recognizable variables induce major changes to weapon system contracts, and how can these variables and the resultant cost growth be more effectively controlled?

As reported by the change principal respondents, the primary recognizable variables that induce major changes to weapon system acquisition contracts are: (1) changes in operational requirements causing changes in the weapon system, (2) incomplete plans and specifications at time of award, (3) changes in program direction/funding (except quantity), and (4) changes in the weapon system to update the system to newly achieved state-of-the-art. Secondary or less influenced variables include: (1) research and development performed in production contracts, (2) inability of the contractor to meet the requirements of the contract plans and specifications, and (3) normal engineering and technical changes.

These variables and the resultant cost growth can be more effectively controlled through continued government and contractor efforts of the type shown in the answers to subsidiary questions 3 and 4 above, and through the use of some of the new ideas and concepts suggested by the change principal respondents and listed as the answer to subsidiary question 9 above.

The report has now reached a point where conclusions can be presented.

The first conclusion deals with the causes of major changes in weapon system production contracts. Based on the majority opinion of change principal respondents, the causes of major changes, in order of importance, are: (1) changes in operational requirements causing change in the weapon system, (2) incomplete plans and specifications at time of

contract award, (3) changes in program direction/funding (except quantity), and (4) changes in the weapon system to update the system to a newly achieved state-of-the-art. A complete summary of the change principals' ranked responses to the question of causes of major changes is provided in Table 22.

The second conclusion concerns the categorization of major change in weapon system acquisition. Fifty-seven percent of the change principal respondents categorized major change as necessary in a viable weapon system acquisition. Based on the opinion of the experts, this report also concludes that major change is necessary in viable weapon system acquisition, and further concludes that major change should be recognized by Congress, the General Accounting Office and the public as a necessary aspect of weapon system acquisition.

The third conclusion deals with constructive changes. Based on the fact that fifty-six percent of the change principal respondents reported that they had not experienced constructive changes in their programs, and because Table 22 shows that the suggested cause "constructive changes" was not chosen by change principal respondents as a cause of major changes, it is concluded that constructive changes are not a primary contributor to the occurrence of major change in weapon system production contracts.

The fourth conclusion has reference to the Department of Defense Configuration Management Programs. Since forty-two

TABLE 22
SUMMARY OF CHANGE PRINCIPALS' RANKED RESPONSES TO
QUESTION OF CAUSES OF MAJOR CHANGES IN
WEAPON SYSTEM PRODUCTION CONTRACTS

Suggested Causes	RANKINGS					Total Times Selected
	1st	2nd	3rd	4th	5th	
a. Accumulation of constructive changes	0	2	3	2	4	11
b. Changes in operational requirements causing change in weapon system	16	9	6	6	6	43
c. Changes in programs direction/funding (except quantity)	8	9	8	5	8	38
d. Changes in weapon system to update system to newly achieved state-of-the-art	7	7	13	4	6	37
e. Inability of the contractor to meet the requirements of the contract plans and specifications	2	4	3	9	3	21
f. Inability of the government to accurately estimate actual weapon system cost	0	4	5	3	2	14
g. Incomplete plans and specifications at time of award	13	10	5	5	5	38
h. Inflation	1	1	3	2	2	9
i. Normal engineering and technical changes	2	7	3	4	5	21
j. R&D performed in production contracts	5	4	6	5	5	25
k. Unknowns in production contracts	1	3	3	6	2	15
l. Other	6	1	1	0	0	8

percent of the change principal respondents reported that the configuration management program was performing satisfactorily and thirty-five percent of the respondents reported that it was performing well, and because a majority of respondents noted that ECP process time standards are being met, it is concluded that the Department of Defense Configuration Management Program is achieving its objectives in a satisfactory or better manner.

The fifth conclusion deals with the feasibility of pre-pricing major changes before directing the contractor to perform them. Because thirty-two percent of the change principal respondents felt that it would be impossible to pre-price major changes, and twenty-three percent of the respondents felt that pre-pricing of major changes could be accomplished only 25% of the time, it is concluded that it is not feasible to pre-price all major changes prior to directing the contractor to perform them.

The sixth conclusion also deals with pre-pricing of major changes. Based on the opinion of ninety-four percent of the change principal respondents, it is concluded that requirements for mandatory pre-pricing of major changes could lead to cost growth and/or system delivery delay.

The seventh conclusion deals with contractor change control efforts. Because fifty-five percent of the government change principal respondents reported that they observed no contractor change control efforts, it is concluded that many defense contractors are either not interested

in the control of major changes, or that their interest in change control has not been demonstrated to government project managers and contracting officers.

The eighth conclusion concerns the Navy's efforts to control the occurrence of constructive changes. Based on the fact that no claims for alleged constructive changes were received during the first three months of 1973, it is concluded that the Navy's efforts in controlling constructive changes have been effective.

The report will not present suggestions for the government and for the defense industry.

The following suggestions are offered to the government with the belief that they represent possible ways to better control the occurrence of major change in weapon system production contracts: (1) It is suggested that the Office of the Secretary of Defense continue to encourage the use of design-to-cost and prototyping concepts in weapon system acquisition. The change principals have clearly noted that these two concepts help control the occurrence of major changes. It is, however, recognized that these concepts may well have other effects still to be determined. (2) It is suggested that the services develop a specific countervailing force, both in project management offices and within the weapon using commands, to consider the adverse effects of proposed changes. (3) It is suggested that the Office of the Secretary of Defense require that defense contractors develop change-by-change cost controls for those major changes valued at a million dollars or more. It was noted

earlier in this report that a few million dollar plus changes represent most of the change dollar expenditures.

(4) It is suggested that the services consider a mandatory change freeze at certain points in the production of weapon systems. As an example, changes could be frozen when a ship is 75% constructed. (5) It is suggested that the services develop a system that would avoid revealing the availability of project/program change money. This system would place the government in a better position to negotiate major contract changes. (6) It is suggested that the services, in conjunction with the Armed Services Procurement Regulations Committee, develop a new "changes clause" that would be responsive to the needs of major changes in weapon system production contracts. (7) It is suggested that the Navy follow the lead of the Air Force and Army and require "ceiling" or "not-to-exceed" pricing of changes to weapon system contracts, rather than require mandatory pre-pricing of these changes.

The following suggestions are offered to the defense industry with the belief that the suggestions represent means to better control major changes, to better achieve successful completion of weapon system contracts and to improve customer relations with the government: (1) It is suggested that proposed changes be approved at different levels in the company, based on their dollar value. For example, at Chrysler Corporation, proposed changes over \$25,000 must be approved by the company program manager and proposed changes over \$50,000 must be approved by a division

manager. (2) It is suggested that contractors develop a system for maintaining change-by-change cost control on changes valued at a million dollars or over. (3) It is suggested that contractors develop a corporate policy to discourage or resist changes requested in the middle of a production run. Note that the changes clause does not direct when nor where a change must be made. (4) It is suggested that all proposed changes pass into and out of the company through the office of the applicable company project manager. (5) It is suggested that the shipbuilding industry quicken their acceptance and implementation of the Department of Defense Configuration Management Program. The program may be difficult to administer, but it is very worthwhile and sorely needed. (6) It is suggested that defense contractors develop internal procedures for reporting suspected constructive changes promptly to the applicable administrative contracting officer. The disingenuous practice of developing large constructive change claims is very harmful to the weapon system acquisition process and to a company's relations with its government customers.

No research report would be complete without noting that as many questions are raised by the research as are answered. This research effort is no exception. The following topics in the area of major changes are considered to be worthy of additional research. They are: (1) A research effort to locate and determine the cause of delays in

processing engineering change proposals. (2) A research effort to determine if it is cheaper to make changes during the production phase or as a retro-fit effort. (3) Research to develop a model contract for major weapon system acquisition. Such a contract could have standard parts and variable parts depending on the weapon system being procured. Research of this type could include new contracted features that respond to major changes, such as the Carin Convertible Contract Clauses found as Appendix O to this report. (4) A research effort to determine why some weapon system acquisitions have fewer changes than others. Lessons could be learned from the comparison of a change-prone system with a like change-free system. (5) Further research into the development of regression equations that can be used to predict the rate of cost growth for different types of weapon systems.

It is earnestly believed that the research effort presented by this report represents a major effort at determining the causes of major changes in weapon system production contracts and at developing new ideas for resolving or reducing the occurrence of major changes. It is hoped that the government and industry will look kindly and with interest on the conclusions and suggestions presented.

APPENDIX A

Questionnaire for DOD Project/Program Managers
on the subject of
Causes of Major Changes in Weapon System Acquisitions

1. In your opinion, which of the following constitutes a major change in weapon system production contracts? (Please check one or more.)
- a. Change in means or method by which weapon system will perform its mission
 - b. Cost of change over \$500,000
 - c. Cost of change over \$1,000,000
 - d. Substantial increase or decrease in weapon system capability
 - e. Substantial change in testing requirements
 - f. Substantial change from GFM/GFE to CFM/CFE or visa versa
 - g. Six months or more slippage/stretchout in delivery date
 - h. Twelve months or more slippage/stretchout in delivery date
 - i. Other (please specify) _____

(Comments, if desired) _____

2. How would you categorize the occurrence of major changes in weapon system production contracts? (Please check one.)
- a. Major challenge
 - b. Management challenge
 - c. Normal problem
 - d. Necessary in a viable weapon system acquisition

(Comments, if desired) _____

Appendix A, continued

3. What do you consider to be the causes of major changes in weapon system production contracts? (Kindly indicate your choice in order of importance by marking them 1 thru 5.)

Rank

- a. Accumulation of constructive (informal) changes _____
- b. Changes in operational requirements causing change in weapon system _____
- c. Changes in program direction/funding (except quantity) _____
- d. Change in weapon system to update system to newly achieved state-of-the-art _____
- e. Inability of the contractor to meet the requirements of the contract plans and specifications _____
- f. Inability of the government to accurately estimate actual weapon system cost _____
- g. Incomplete plans and specifications at time of award _____
- h. Inflation _____
- i. Normal engineering and technical changes _____
- j. R&D performed in production contracts _____
- k. Unknowns in production contracts _____
- l. Other (please specify) _____

(Comments, if desired) _____

Appendix A, continued

4. Has your Project/Program experienced constructive (informal) contract changes? Yes _____ No _____

If yes, which of the following types of constructive changes have you experienced? (Please check one or more.)

- a. Acceleration of work directed by persons other than the contracting officers
- b. Drawings were defective in that they contained errors, omissions, inaccuracies or inconsistencies
- c. Government-provided information, documentation or approvals were late, defective or subsequently revised
- d. Improper inspection, quality assurance and/or rejection of work
- e. Specifications or contract provisions were "impossible to perform" because they require work beyond the state-of-the-art or R&D effort
- f. Specifications or contract provisions were "impossible to perform" because of conflicting or erroneous requirements
- g. Specifications or contract provisions were unclear in that they were open to more than one interpretation or application
- h. Technical direction by persons other than contracting officers
- i. Other (please specify) _____

(Comments, if desired) _____

Appendix A, continued

5. If you have experienced constructive changes, what practices have you found effective in your Project/Program in controlling these type changes? (Your comments please. Use back of page if additional space is required.)

6. How is the DOD Configuration Management Program (DOD Directives 5010.19 and 5010.21, MIL-STD 480, AFSC Manual 371-1, etc.) functioning in your Project/Program? (Please check one.)

- a. Well
- b. Satisfactorily
- c. Marginally
- d. Unsatisfactorily

7. The DOD time standards for processing Engineering Change Proposals (ECP's) are: Emergency - 24 hours from proposal receipt
Urgent - 15 days from proposal receipt
Routine - 45 days from proposal receipt

Does your CM program generally meet these standards? Yes _____ No _____

8. What deficiencies, if any, do you find in the present DOD Configuration Management Program? (Your comments please)

9. What recommendations could you offer for improvement in the present DOD Configuration Management Program? (Your comments please. Use back of page if additional space is required.)

Appendix A, continued

10. To what extent would it be possible to price all major changes prior to directing the contractor to perform them? (Please check one)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(Comments, if desired) _____

11. Do you consider that a requirement for the pre-pricing of major changes in the weapon system which you manage would cause delivery delays and/or cost growth in the weapon system? Yes _____ No _____
(Comments, if desired) _____

12. To what extent would it be possible to obtain a ceiling/not to exceed price for major changes prior to their formal issuance to the contractor by the Administrative Contracting Officer? (Please check one.)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(Comments, if desired) _____

Appendix A, continued

13. What efforts have you seen made by the prime and/or sub-contractor(s) for your Project/Program which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

14. What efforts have you observed made by OSD or the Military Departments within the last three years which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

15. What new ideas/concepts do you personally consider would help reduce/resolve the occurrence of major changes in weapon system production contracts? (Your comments please. Use back of page if additional space is required.)

In order to retain anonymity, please do not sign or identify your organization on this questionnaire.

If you have any questions concerning the questionnaire, please call collect CDR Art Meiners (SC) USN at (703) 323-7719 in Washington, D.C.

APPENDIX B

Questionnaire for Contractor Project/Program Managers
on the subject of
Causes of Major Changes in Weapon System Acquisition

1. In your opinion, which of the following constitutes a major change in weapon system production contracts? (Please check one or more.)
- a. Change in means or method by which weapon system will perform its mission
 - b. Cost of change over \$500,000
 - c. Cost of change over \$1,000,000
 - d. Substantial increase or decrease in weapon system capability
 - e. Substantial change in testing requirements
 - f. Substantial change from GFM/GFE to CPM/CFE or visa versa
 - g. Six months or more slippage/stretchout in delivery date
 - h. Twelve months or more slippage/stretchout in delivery date
 - i. Other (please specify) _____

(Comments, if desired) _____

2. How would you categorize the occurrence of major changes in weapon system production contracts? (Please check one.)
- a. Major challenge
 - b. Management challenge
 - c. Normal problem
 - d. Necessary in a viable weapon system acquisition

(Comments, if desired) _____

Appendix B, continued

3. What do you consider to be the causes of major changes in weapon system production contracts? (Kindly indicate your choice in order of importance by marking them 1 thru 5.)

	Rank
a. Accumulation of constructive (informal) changes	_____
b. Changes in operational requirements causing change in weapon system	_____
c. Changes in program direction/funding (except quantity)	_____
d. Change in weapon system to update system to newly achieved state-of-the-art	_____
e. Inability of the contractor to meet the requirements of the contract plans and specifications	_____
f. Inability of the government to accurately estimate actual weapon system cost	_____
g. Incomplete plans and specifications at time of award	_____
h. Inflation	_____
i. Normal engineering and technical changes	_____
j. R&D performed in production contracts	_____
k. Unknowns in production contracts	_____
l. Other (please specify) _____	_____
_____	_____
_____	_____

(Comments, if desired) _____

Appendix B, continued

4. Has your Project/Program experienced constructive (informal) contract changes? Yes _____ No _____

If yes, which of the following types of constructive changes have you experienced? (Please check one or more.)

- a. Acceleration of work directed by persons other than the contracting officers
- b. Drawings were defective in that they contained errors, omissions, inaccuracies or inconsistencies
- c. Government-provided information, documentation or approvals were late, defective or subsequently revised
- d. Improper inspection, quality assurance and/or rejection of work
- e. Specifications or contract provisions were "impossible to perform" because they require work beyond the state-of-the-art of R&D effort
- f. Specifications or contract provisions were "impossible to perform" because of conflicting or erroneous requirements
- g. Specifications or contract provisions were unclear in that they were open to more than one interpretation or application
- h. Technical direction by persons other than contracting officers
- i. Other (please specify) _____

(Comments, if desired) _____

Appendix B, continued

5. If you have experienced constructive changes, what practices have you found effective in your Project/Program in controlling these type changes? (Your comments please. Use back of page if additional space is required.)

6. How is the DOD Configuration Management Program (DOD Directives 5010.19 and 5010.21, MIL-STD 480, AFSC Manual 371-1, etc.) functioning in your Project/Program? (Please check one.)

- a. Well
- b. Satisfactorily
- c. Marginally
- d. Unsatisfactorily

7. The DOD time standards for processing Engineering Change Proposals (ECP's) are: Emergency - 24 hours from proposal receipt
Urgent - 15 days from proposal receipt
Routine - 45 days from proposal receipt

Is the government generally meeting these standards in your Project/Program? Yes _____ No _____

8. What deficiencies, if any, do you find in the present DOD Configuration Management Program? (Your comments please)

9. What recommendations could you offer for improvement in the present DOD Configuration Management Program? (Your comments please. Use back of page if additional space is required.)

Appendix B, continued

10. To what extent would it be possible for you and the government to price all major changes before they were accepted by your company? (Please check one.)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(Comments, if desired) _____

11. Do you consider that a requirement for pre-pricing of major changes in the weapon system which you are producing could cause delivery delays or cost growth in the weapon system? Yes _____ No _____
(Comments, if desired) _____

12. To what extent would it be possible for you and the government to agree to a ceiling/not to exceed price for a major change prior to your acceptance of the change? (Please check one.)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(Comments, if desired) _____

Appendix B, continued

13. What efforts has your company made in the last three years to control occurrence of major changes? (Comments solicited)

14. What efforts have you observed made by OSD or the Military Departments within the last three years which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

15. What new ideas/concepts do you personally consider would help reduce/resolve the occurrence of major changes in weapon system production contracts? (Your comments please. Use back of page if additional space is required.)

In order to retain anonymity, please do not sign or identify your organization on this questionnaire.

If you have any questions concerning the questionnaire, please call collect CDR Art Meiners (SC) USN at (703) 323-7719 in Washington, D.C.

APPENDIX C

Questionnaire for DOD Procuring Contracting Officers
on the subject of
Causes of Major Changes in Weapon System Acquisition

1. In your opinion, which of the following constitutes a major change in weapon system production contracts? (Please check one or more.)
- a. Change in means or method by which weapon system will perform its mission
 - b. Cost of change over \$500,000
 - c. Cost of change over \$1,000,000
 - d. Substantial increase or decrease in weapon system capability
 - e. Substantial change in testing requirements
 - f. Substantial change from GFM/GFE to CFM/CFE or visa versa
 - g. Six months or more slippage/stretchout in delivery date
 - h. Twelve months or more slippage/stretchout in delivery date
 - i. Other (please specify) _____
- _____
- _____

(Comments, if desired) _____

2. How would you categorize the occurrence of major changes in weapon system production contracts? (Please check one.)
- a. Major challenge
 - b. Management challenge
 - c. Normal problem
 - d. Necessary in a viable weapon system acquisition

(Comments, if desired) _____

Appendix C, continued

3. What do you consider to be the causes of major changes in weapon system production contracts? (Kindly indicate your choice in order of importance by marking them 1 thru 5.)

Rank

- a. Accumulation of constructive (informal) changes _____
- b. Changes in operational requirements causing change in weapon system _____
- c. Changes in program direction/funding (except quantity) _____
- d. Change in weapon system to update system to newly achieved state-of-the-art _____
- e. Inability of the contractor to meet the requirements of the contract plans and specifications _____
- f. Inability of the government to accurately estimate actual weapon system cost _____
- g. Incomplete plans and specifications at time of award _____
- h. Inflation _____
- i. Normal engineering and technical changes _____
- j. R&D performed in production contracts _____
- k. Unknowns in production contracts _____
- l. Other (please specify) _____

(Comments, if desired) _____

Appendix C, continued

4. Have large-weapon system production contracts which you awarded experienced constructive changes? Yes _____ No _____

If yes, which of the following types of constructive changes have you experienced? (Please check one or more.)

- a. Acceleration of work directed by persons other than the contracting officers
- b. Drawings were defective in that they contained errors, omissions, inaccuracies or inconsistencies
- c. Government-provided information, documentation or approvals were late, defective or subsequently revised
- d. Improper inspection, quality assurance and/or rejection of work
- e. Specifications or contract provisions were "impossible to perform" because they require work beyond the state-of-the-art or R&D effort
- f. Specifications or contract provisions were "impossible to perform" because of conflicting or erroneous requirements
- g. Specifications or contract provisions were unclear in that they were open to more than one interpretation or application
- h. Technical direction by persons other than contracting officers
- i. Other (please specify) _____

(Comments, if desired) _____

Appendix C, continued

5. To what extent do you believe that the anti-claims clauses currently being utilized by the Navy in weapon system contracts can alleviate the problem of constructive changes in weapon system production contracts? (Please check one.)

- a. They can alleviate all the problem of constructive changes
- b. They can alleviate about 75% of the problem
- c. They can alleviate about 50% of the problem
- d. They can alleviate about 25% of the problem
- e. They cannot alleviate any of the problem

6. To what extent would it be possible to price all major changes prior to directing the contractor to perform them? (Please check one.)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(Comments, if desired) _____

7. Do you consider that a requirement for the pre-pricing of major changes in the weapon system contracts which you awarded could cause delivery delays and/or cost growth in the weapon systems? Yes _____ No _____ (Comments, if desired) _____

8. To what extent would it be possible to obtain a ceiling/not to exceed price for major changes prior to their formal issuance to the contractor by the Administrative Contracting Officer? (Please check one.)

- a. Could be easily done
- b. Could be done on 75% of major changes

(continued on next page)

Appendix C, continued

c. Could be done on 50% of major changes

d. Could be done on 25% of major changes

e. Impossible

(Comments, if desired) _____

9. What efforts have you seen made by the prime and/or sub-contractor(s) for large weapon system acquisitions which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

10. What efforts have you observed made by OSD or the Military Departments within the last three years which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

11. What new ideas/concepts do you personally consider would help reduce/resolve the occurrence of major changes in weapon system production contracts? (Your comments please. Use back of page if additional space is required.)

In order to retain anonymity, please do not sign or identify your organization on this questionnaire.

If you have any questions concerning the questionnaire, please call collect CDR Art Meiners (SC) USN at (703) 323-7719 in Washington, D.C.

APPENDIX D

Questionnaire for DOD Administrative Contracting Officer
on the subject of
Causes of Major Changes in Weapon Systems Acquisition

1. In your opinion, which of the following constitutes a major change in weapon system production contracts? (Please check one or more.)

- a. Change in means or method by which weapon system will perform its mission
- b. Cost of change over \$500,000
- c. Cost of change over \$1,000,000
- d. Substantial increase or decrease in weapon system capability
- e. Substantial change in testing requirements
- f. Substantial change from GFM/GFE to CFM/CFE or visa versa
- g. Six months or more slippage/stretchout in delivery date
- h. Twelve months or more slippage/stretchout in delivery date
- i. Other (please specify) _____

(Comments, if desired) _____

2. How would you categorize the occurrence of major changes in weapon system production contracts? (Please check one.)

- a. Major challenge
- b. Management challenge
- c. Normal problem
- d. Necessary in a viable weapon system acquisition

(Comments, if desired) _____

Appendix D, continued

3. What do you consider to be the causes of major changes in weapon system production contracts? (Kindly indicate your choice in order of importance by marking them 1 thru 5.)

Rank

- a. Accumulation of constructive (informal) changes _____
- b. Changes in operational requirements causing change in weapon system _____
- c. Changes in program direction/funding (except quantity) _____
- d. Change in weapon system to update system to newly achieved state-of-the-art _____
- e. Inability of the contractor to meet the requirements of the contract plans and specifications _____
- f. Inability of the government to accurately estimate actual weapon system cost _____
- g. Incomplete plans and specifications at time of award _____
- h. Inflation _____
- i. Normal engineering and technical changes _____
- j. R&D performed in production contracts _____
- k. Unknowns in production contracts _____
- l. Other (please specify) _____

(Comments, if desired) _____

Appendix D, continued

4. Has the applicable weapon system production contract which you are administering experienced constructive changes? Yes_____ No_____

If yes, which of the following types of constructive changes have been experienced? (Please check one or more.)

- a. Acceleration of work directed by persons other than the contracting officers
- b. Drawings were defective in that they contained errors, omissions, inaccuracies or inconsistencies
- c. Government-provided information, documentation or approvals were late, defective or subsequently revised
- d. Improper inspection, quality assurance and/or rejection of work
- e. Specifications or contract provisions were "impossible to perform" because they require work beyond the state-of-the-art or R&D effort
- f. Specifications or contract provisions were "impossible to perform" because of conflicting or erroneous requirements
- g. Specifications or contract provisions were unclear in that they were open to more than one interpretation or application
- h. Technical direction by persons other than contracting officers
- i. Other (please specify) _____

(Comments, if desired) _____

Appendix D, continued

5. How is the DOD Configuration Management Program (DOD Directives 5010.19 and 5010.21, MIL-STD 480, AFSC Manual 371-1, etc.) functioning relative to the weapon system production contract which you are administering? (please check one.)

- a. Well
- b. Satisfactorily
- c. Marginally
- d. Unsatisfactorily

6. The DOD time standards for processing Engineering Change Proposals (ECP's) are: Emergency - 24 hours from proposal receipt
Urgent - 15 days from proposal receipt
Routine - 45 days from proposal receipt

If the government meeting these standards for the weapon system production contract that you are administering? Yes ___ No ___

7. What deficiencies, if any, do you find in the present DOD Configuration Management Program? (Your comments please)

8. What recommendations could you offer for improvement in the present DOD Configuration Management Program? (Your comments please. Use back of page if additional space is required.)

9. To what extent would it be possible to price all major changes prior to directing the contractor to perform them? (Please check one)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(continued on next page)

Appendix D, continued

(Comments, if desired) _____

10. Do you consider that a requirement for the pre-pricing of major changes in the weapon system production contract which you are administering could cause delivery delays? Yes _____ No _____
(Comments, if desired) _____

11. To what extent would it be possible to obtain a ceiling/not to exceed price for major changes prior to their formal issuance to the contractor by the Administrative Contracting Officer? (Please check one.)

- a. Could be easily done
- b. Could be done on 75% of major changes
- c. Could be done on 50% of major changes
- d. Could be done on 25% of major changes
- e. Impossible

(Comments, if desired) _____

12. What efforts have you seen made by the prime and/or sub-contractor(s) for your Project/Program which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

Appendix D, continued

13. What efforts have you observed made by OSD or the Military Departments within the last three years which have or could lead to better control of occurrence of major changes? (Your comments please. Use back of page if additional space is required.)

14. What new ideas/concepts do you personally consider would help reduce/resolve the occurrence of major changes in weapon system production contracts? (Your comments please. Use back of page if additional space is required.)

In order to retain anonymity, please do not sign or identify your organization on this questionnaire.

If you have any questions concerning the questionnaire, please call collect CDR Art Meiners (SC) USN at (703) 323-7719 in Washington, D.C.

APPENDIX E

LARGE IN-PRODUCTION WEAPON SYSTEMS
USED FOR THIS STUDY
(DOLLARS IN MILLIONS)

WEAPON SYSTEM	SYSTEM CURRENT ESTIMATED COST ^a	COST GROWTH THRU DEC. 31, 1972 ^b
A7E Aircraft	\$2,776.0	\$1,060
E-2C Aircraft	873.8	286
F-14 Aircraft	5,271.6	253
P-3C Aircraft	2,487.0	229
Condor Missile	524.8	229
Phoenix Missile	1,113.7	561
Sparrow III F Missile	1,276.9	549
MK 48 MOD 1 Torpedo	1,957.9	219
LHA Ship	970.0	262
CVAN 68/69 Ship	1,316.2	274
VAST Electronics System	435.4	303
SSN 688 Submarines	8,096.1	565
MGO Tank	402.8	241
Dragon Missile	484.7	222
TOW Missile	651.6	272
Improved Hawk Missile	758.3	305
SAM-D Missile	5,240.5	-
SAFEGUARD SYSTEM	7,975.0	2,053
Lance Missile	776.6	127
C-5A Aircraft	4,526.4	1,806
F-5E Aircraft	297.4	7
F-111 Aircraft	6,994.6	4,060
Maverick Missile	385.3	97
Minuteman III Missile	6,110.5	1,630
SRAM Missile	<u>1,325.9</u>	<u>848</u>
	\$63,030.0	\$16,458

a. General Accounting Office Report B-163058 dated March 26, 1973

b. OASD (Comptroller) Report dated December 31, 1972



APPENDIX F

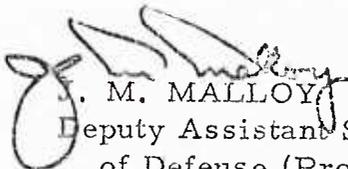
OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

INSTALLATIONS AND LOGISTICS

25 FEB 1973

TO WHOM IT MAY CONCERN:

This letter introduces Commander Arthur C. Meiners, Jr. (SC) USN, a Navy doctoral student at George Washington University. Commander Meiners is presently engaged in academic research concerning causes of major changes during the acquisition phase of defense systems in connection with his doctoral dissertation on that same subject. It is requested that you provide Commander Meiners reasonable assistance by completing an unclassified questionnaire on this subject. The proposed questionnaire process will be handled within a framework of anonymity for those who participate. The results of Commander Meiners' research will be reviewed by my staff.


J. M. MALLOY
Deputy Assistant Secretary
of Defense (Procurement)

APPENDIX G



THE GEORGE WASHINGTON UNIVERSITY/ WASHINGTON, D. C. 20006

SCHOOL OF GOVERNMENT AND

BUSINESS ADMINISTRATION

DEPARTMENT OF BUSINESS ADMINISTRATION

Mr.
Procuring Contracting Officer, SAFEGUARD System
U.S. Army Munitions Command
Dover, New Jersey 07801

Dear Mr. ,

This letter forwards a questionnaire designed to develop data for a doctoral dissertation at The George Washington University. The dissertation research is concerned with causes of major changes and resultant cost growth in defense weapon system production contracts.

I also enclose an open letter from Deputy Assistant Secretary of Defense (Procurement) John Malloy, soliciting your cooperation in this research effort. As mentioned in Mr. Malloy's letter, extreme care is being taken to safeguard the anonymity of respondents.

It is respectfully requested that the questionnaire be completed and returned in the attached self-addressed stamped envelope. Please note that a collect telephone number is listed on the last page of the questionnaire in case you have any questions concerning the questionnaire or its use.

Respondents who so desire will be provided with a summary of replies.

Thank you for your help and cooperation.

Sincerely,

Arthur C. Meiners, Jr.
CDR (SC) USN



APPENDIX H

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

INSTALLATIONS AND LOGISTICS

December 12, 1972

TO WHOM IT MAY CONCERN:

This letter introduces Commander Arthur C. Meiners, Jr. (SC) USN, a Navy doctoral student at George Washington University. Commander Meiners is presently engaged in academic research concerning causes of major changes during the acquisition phase of defense systems in connection with his doctoral dissertation on that same subject. It is requested that you provide Commander Meiners reasonable assistance in the form of unclassified interviews on this subject. The proposed interviews would be conducted within a framework of anonymity for those interviewed. The results of Commander Meiners' research will be reviewed by my staff.

A handwritten signature in black ink, appearing to read "J. M. Malloy", is written over the typed name.

J. M. MALLOY
Deputy Assistant Secretary
of Defense (Procurement)

APPENDIX I

ENGINEERING CHANGE PROPOSAL PRIORITY CATEGORIES

- I. Emergency. This priority is assigned to changes proposed for the following reasons:
- A. To effect a change in operational characteristics which, if not accomplished without delay, may seriously compromise the national security.
 - B. To correct a hazardous condition which may result in fatal or serious injury to personnel, or in extensive damage or destruction of equipment.

Decisions on emergency change proposals should be made within 24 hours of receipt.

- II. Urgent. This priority is assigned to changes proposed for the following reasons:
- A. To effect a change in operational characteristics which, if not accomplished expeditiously, may seriously compromise the mission effectiveness of deployed equipment.
 - B. To correct a potentially hazardous condition which may result in serious injury to personnel, or in damage to equipment.
 - C. To meet significant contractual requirements when lead time will necessitate slipping

APPENDIX I, cont.

approved production, activation or construction schedules, if the change were not incorporated.

- D. To effect an interface change which, if delayed, would cause a schedule slippage or increased cost.
- E. To effect, through value engineering or other cost reduction efforts, net life cycle savings to the Government of more than one hundred thousand dollars, where expedited processing of the change will be a major factor in realizing these lower costs.

Decisions on urgent change proposals should be made within fifteen days of proposal receipt.

III. Routine. This priority covers all other changes not included in "emergency" or "urgent".

Decisions on these change proposals should be made within forty-five days of proposal receipt.

Source: U.S. Department of Defense. Configuration Management Implementation Guidance. DOD Instruction 5010.21. Washington, D.C.: Department of Defense, August 6, 1968, pp. 6-7.

APPENDIX J

NAVY CHANGE PROPOSAL EVALUATION QUESTIONS

- I. How necessary is the change?
 - A. Is it a design deficiency which will jeopardize the essential military or operational requirements and seriously affect the aircraft/ship/weapons' ability to perform its assigned mission?
 - B. Is it one involving a new concept of operation or new threat which will require drastic redesign of hardware already in full-scale development or production?
 - C. Is it one which could result in improvement of logistic support requirements but the logistics costs are future costs and must therefore be calculated by prediction techniques?
- II. What is the priority of the change?
 - A. Is it one which is needed to correct an existing hazardous condition which could result in fatal or serious injury to operating personnel or in extensive damage to hardware?
 - B. Is it one to affect a logistic support requirement having no impact upon production or delivery schedule?

APPENDIX J, cont.

III. What is the estimated gross or net cost of the change?

A. Is the cost of the change so great as to warrant an overall change in program funding?

IV. Have other alternatives been considered over and above the proposed change?

A. Have several design approaches been considered?

B. Have several production methods been considered?

V. What is the impact of the change on scheduled contract deliveries?

A. What is the effect on scheduled operational deployment?

B. What is the effect on personnel assignments?

Source: U.S. Department of Defense. Principles of Management of Change Within the Navy. Chief of Naval Material Paper. Washington, D.C.: Department of the Navy, April 13, 1971, pp. 12-13.

APPENDIX K

New Configuration Management Priority System Proposed By An Army Project Manager

1. Emergency - Simple design changes involving simple dimensions or material substitutions which arise from production assembly or standard procurement problems. The evaluation of ECP's of this type is possible within a limited time frame. The extent of this time frame is recommended to be 48 hours to enable adequate evaluation prior to authorization.. The paper can hardly be hand-carried through the channels within the current 24 hour limit.

2. Urgent - All Class I ECP's except Emergency which affect a current hardware contract. The recommended extent of this time frame is 21 days, since the bulk of the work is accomplished and normal distribution/internal mail channels must be utilized. This 21 day span would roughly divide into 14 days from receipt to Configuration Advisory Board action, three days for Configuration Management Office processing and four days for procurement office processing.

3. Routine - All Class I ECP's which do not affect a current hardware contract and all Class II ECP's. The current forty-five day time frame is considered reasonable.

APPENDIX L

Listing of Suggestions from Project Managers for Resolution/Reduction of Occurrence of Major Change in Weapon System Production Contracts

NAVY PM SUGGESTIONS

1. Use of cost-type contracts for development and prototype contracts.
2. Services be satisfied with less than state-of-the-art product at delivery.
3. Know capabilities and limitations of contractor prior to award of contract.
4. Realistic budgeting of expense of programs.
5. Force a system of determining "return cost" in evaluating changes.
6. Accelerate the early identification of changes.
7. No major changes implemented after a certain date or certain percentage of completion of the production contract.
8. Establish a firm cut-off date for considering change to production contracts.
9. Turn a lot of changes down.
10. Develop closer monitoring of situations or problems that could develop into major changes.
11. Find a better way to sell and start a weapon system program without having to oversell it and promise a performance/cost/schedule package that likely would not happen.
12. Configuration identity and status data records should be established early and during the pre-production test phase these configuration records can form the base of departure for engineers and designers to assess needed changes.
13. Develop a "go-slow" approach of accepting delay and "proving-in" production prototypes.
14. Discourage system customers from forcing late marginal "improvements".

15. Accomplish technical evaluation before starting operational evaluation.
16. Accept fact that anything "operational" is either obsolescent or obsolete.
17. Stick with planned design and discourage suggestions of changes by outside commands..

AIR FORCE PM SUGGESTIONS

1. Stable funding for weapon system programs.
2. Earlier program decisions and direction.
3. Strong program discipline that will say "no" to changes.
4. Quarterly review of defense acquisition programs similar to Air Force Program Assessment Review (PAR) to resolve major problems.
5. Develop a system to provide the project managers with more information relative to the make-up of indirect costs associated with major changes.
6. Program manager keep in constant face-to-face contact with the contractor on performance, cost and schedule.
7. Program manager maintain maximum visibility regarding all project events to prevent surprises and cut off "gold plating".
8. More government competency and management projection of possible problem aspects with current audits to identify any problem in its initial stage in order to minimize program impact.

ARMY PM SUGGESTIONS

1. Develop a "firm definitive need" approach to changes that is supported by all agencies.
2. Increased baseline definition for development and design to cost.
3. Complete and thorough testing prior to production go ahead.

4. Completing of all research and development prior to start of production.
5. Let the project manager manage without so much uninspired, **uninformed** guidance.
6. Earlier program decisions, especially regarding quantity of the weapon system the contractor is to produce.

APPENDIX M

List of Suggestions from Defense Contractors for Resolution/Reduction of Occurrence of Major Change in Weapon System Production Contracts

NAVY CONTRACTOR SUGGESTIONS

1. More simply stated requirements and more flexibility for a contractor to meet those requirements.
2. It would be better for a small government project organization to monitor the contractor and the contractor could use a smaller project organization to interface with the government organization.
3. Closer liason between the actual user and the technical community regarding future operational requirements will permit many of these requirements to be included in the original procurement specification and reduce the number of major changes.
4. Stabilization of quantity/production rate by better long range planning, particularly in area of funding.
5. Less frequent turnover of military in project offices and supporting technical organizations.
6. Better control of engineers as their basic education is oriented around change.
7. We must determine how good is good enough and buy only that which is necessary.

AIRFORCE CONTRACTOR SUGGESTIONS

1. Divorce R&D and test from production.
2. Reverse the trend of the Government trying to manage every aspect of contractors' procedures, policies and operations, and control the contract with proper incentives.
3. Use the study/review team concept prior to change definition/initiation.
4. Prototype testing to determine the configuration desired prior to starting production.
5. Better understanding of the using organization requirements.

6. Fully fund development programs.
7. Utilize Fly-Before-Buy Acquisition
8. Fund changes at a minimum or develop a way to hide change money.

ARMY CONTRACTOR SUGGESTIONS

1. Validate the design of a weapon system in the R&D stage and freeze design except for manufacturing problems.
2. Observe restraint in production improvement changes.
3. Recognize the need for changes early in the program (either before or early in the production cycle), encourage and expedite (perhaps incentivize) rather than inhibit, making these changes early when they have minimum impact rather than later when they can have a major impact.
4. Develop a new type production contract for weapon system acquisition that would recognize the existence of major change.
5. Place responsible project managers above rather than at the bottom of the paper-pushing bureaucracy.

APPENDIX N

List of Suggestions from Defense Contracting Officers for Resolution/Reduction of Occurrence of Major Change in Weapon System Production Contracts

NAVY PROCURING CONTRACTING OFFICER SUGGESTIONS

1. Development changes must be made before the production phase.
2. Efforts must be made to reduce redirection of weapon system programs due to money problems.
3. Utilize a pilot production contract before going into full production.
4. Complete testing and evaluation before entering production phase.
5. Beware of contractor "buy-ins".
6. Develop clear definition of the weapon system program prior to commencement.
7. Encourage contractor project managers to realize the importance of limiting changes.
8. Encourage timely funding of multi-year weapon system acquisitions by Congress.
9. DOD should not accept weapon systems on waivers while contractors are trying to debug or prove-out their systems.
10. Complete development before beginning production phase and then do not tolerate any changes.
11. Encourage strong control of changes through change control boards.
12. Evaluate and reward service project managers for their ability to control changes as well as the technical and operational success of their project.

Appendix N, cont.

13. Strong implementation of DOD Directive 5000.1 acquisition policy.
14. Do away with the Armed Services Procurement Regulations changes clause, except for bi-lateral safety changes.
15. Consider cost-type contracts for major weapon system in lieu of fixed price contracts.
16. Consider the contractor's over-all capability before awarding weapon system production contracts.
17. Consider front-end costing on lead ships through cost plus fixed fee or cost plus incentive fee contracts.
18. Implement DOD Directive 7000.2 concerning contractor schedule and cost control systems.
19. Budget changes on the basis of the work package approach.
20. Develop some sort of monetary control for change money.
21. Change disbursement to pay-as-you-go, which would encourage contractors to price changes faster.
22. Allow only safety of flight changes during current year and make accumulated other changes on the next year buy.

AIR FORCE PROCURING CONTRACTING OFFICERS

1. Establish a position of assistant project manager for business management, who would have an equal voice with the technical managers regarding proposed changes.
2. Require the user/customer to fund changes they request.
3. Avoid using production contracts to "push" the state-of-the-art.
4. Allow time in the production schedules for change impacts.

Appendix N, cont.

ARMY PROCURING CONTRACTING OFFICERS

1. Hold changes to a minimum.
2. Do not exercise changes which stop the production line.
3. Tighten change control procedures.

NAVY ADMINISTRATIVE CONTRACTING OFFICER SUGGESTIONS

1. Continue "fly-before-you-buy" acquisition policy.
2. Learn better how to live with major changes. **The** cheapest and least disruptive change is the one that is resolved prior to start of the changed work.
3. Present emphasis on pre-pricing is forcing program and technical managers into instituting changes via illegitimate out-of-scope technical direction, resulting in complete loss of control concerning changes.
4. Institute tight configuration management.
5. Change current acquisition philosophy that we must have all of the latest possible improvements right now.
6. Require more literal compliance with existing statutes and regulations.
7. Dispense more authority to the field activities.
8. Contractors should be rewarded for worthwhile ECP's.
9. Utilize "Truth in Negotiations" Public Law 87-653 for major changes requiring the contractor to provide factual data on changes.
10. Develop a "will cost" approach to major changes.
11. Consider use of cost plus award fee contracts for major weapon system acquisition.

AIR FORCE ADMINISTRATIVE CONTRACTING OFFICER SUGGESTIONS

1. Consider model contract experimentation for major weapon system acquisition.
2. Require the service project manager to personally approve all changes.

Appendix N, cont.

3. Require a new contract for each out-of-scope new requirement.
4. All changes should be reviewed prior to implementation.
5. Start and complete research, development, test and evaluation early and complete prior to starting **production** stage.
6. Increased use of pre-production prototyping in proven and low-risk concepts.
7. Test the system prior to production and then do not change the requirement.

ARMY ADMINISTRATIVE CONTRACTING OFFICER SUGGESTIONS

1. Provide uninterrupted funding for major weapon system acquisition.
2. It is probably not possible to resolve the occurrence of major changes in weapon system production contracts. We have been trying to solve the problem for the last 25 years and have not been successful.

APPENDIX O

Carin "Convertible Contract" Clauses

Background

Normally in the course of contract performance a number of change orders are issued under the basic contract. When these change orders are of a minor nature the firming-up of price as a result of the revised or modified effort can be accomplished with little difficulty. However, when major change orders are issued involving revisions that are substantive and of great magnitude, factors may be interjected which can make it most difficult for the contractor and the government to reach agreement on an equitable adjustment to the contract price. It is believed that a "convertible contract", if utilized with care and skill, will significantly resolve this problem.

The clauses which follow convey the inner workings of a "convertible contract". The clauses are written for a firm fixed-price contract, but could be revised and modified to fit fixed-price incentive, cost-plus-incentive-fee and cost-plus-fixed-fee contracts.

Clause 1

Notwithstanding any other provisions in this contract, the contractor agrees to maintain records of all costs incurred in the performance of this firm fixed-price contract

Appendix O, cont.

in the same manner as cost reimbursement type contracts and in accordance with ASPR requirements established for contracts containing redeterminable type provisions. However, cost data shall be considered proprietary to the contractor, unless Clause 3 below becomes operative.

Clause 2

Notwithstanding any other provisions in the contract, it is agreed that any change orders issued pursuant to the changes clause and generating an increase in contract price shall be negotiated on a Cost-Plus-Award-Fee Basis; however, the Contracting Officer and the Contractor may mutually agree to another type of pricing if considered to be more appropriate.

Clause 3

This clause shall become operative in the event that the Contracting Officer and the Contractor are unable to agree to a price adjustment with respect to any change order issued under this contract. (This may be due to such factors as delay, disruption or an aggregate of voluminous varied-dollar change orders.) Should the foregoing occur and the Contracting Officer determine that the disagreement involves a significant increase in the contract price, the Contracting Officer, at his option, may convert the entire contract to Cost-Plus-Award-Fee. However, the Contracting Officer and the Contractor may mutually agree to convert to another contract type if that type is considered

Appendix O, cont.

to be more appropriate. Within 30 days after receiving notice from the Contracting Officer that the option will be exercised to convert this contract from Firm Fixed-Price to Cost-Plus-Award-Fee, the contractor agrees to submit a detailed statement, up to the date of notification, of all costs reasonably incurred and proper allocable to work performed under this contract. The contractor agrees to submit an estimate of cost of such further performance, if any, as may be necessary to complete performance of all work. All work authorized by the Government and for which final prices have not been established will be included in this cost estimate.

Comment

The "convertible" feature is not intended to be used to reopen the pricing of contracts. Rather, it is intended as an instrument for controlling contracts that have, in effect, already been reopened due to the issuance of significant change orders. Perhaps the latter **situation** has often times occurred and there has been a reluctance to fully recognize the condition.

The convertible contract concept was developed by Mr. Phillip Carin, of the Procurement Control and Clearance Division in the Naval Material Command Headquarters.

BIBLIOGRAPHY

BOOKS

- Baumgartner, John Stanley. Project Management. Homewood, Ill.: Richard D. Irwin, Inc., 1963.
- Changes and Changed Conditions. Washington, D.C.: Federal Publications, Inc., 1962.
- Cleland, David I. and King, William R. Systems Analysis and Project Management. New York: McGraw Hill, 1968.
- Contract Administration Vols I & II. The Ohio State University Research Foundation, 1971.
- Peck, Merton J. and Scherer, Frederic M. The Weapons Acquisition Process: An Economic Analysis. Boston, Mass.: Division of Research, Graduate School of Business, Harvard University, 1962.
- Proxmire, William. Report from Wasteland. Washington, D.C.: Praeger, 1970.
- Reimer, W.H. Handbook of Government Contract Administration. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968.
- Roman, Daniel D. Research and Development Management: The Economics and Administration of Technology. New York: Appleton-Century-Crofts, 1968.
- Scherer, Frederic M. The Weapons Acquisition Process: Economic Incentives. Boston: Harvard University Press, 1964.
- Silverman, Melvin. The Technical Program Managers Guide to Survival. New York: John Wiley and Sons, Inc., 1967.
- U.S. Department of Defense. Armed Services Procurement Regulations Manual for Contract Pricing, ASPM No 1. Washington, D.C.: Government Printing Office, February 14, 1969.
- U.S. Department of Defense. Armed Services Procurement Regulations (ASPR). Washington, D.C.: Government Printing Office, 1969.

OFFICIAL DOCUMENTS

- Ankley, William J. "Costing the MBT-70, An Example of Chaos." Paper at U.S. Army War College, Carlisle Barracks, Penna., March 27, 1968.
- Buckingham, Charles E. Cost Control During the System Acquisition Process - A Guide for System/Project Managers. Washington, D.C.: Industrial College of the Armed Forces, 1967.
- Cummins, J. Michael, Williams, William B. and Carter, Shirley H. Production Cost Growth. Fort Lee, Va.: U.S. Army Procurement Research Office, March, 1971.
- Gibson, W. Scott. System For Program Expenditure Control (SPEC). A Research Report for Air War College, Air University, Maxwell Air Force Base, Alabama, May, 1967.
- Heffron, Michael. "Analysis of SCN Costs FY 1961-FY 1967." Washington, D.C.: Center for Naval Analysis, November 20, 1968.
- Heffron, Michael. "Heffron Report, September 1970." Unpublished report for the Center for Naval Analysis, Arlington, Va., September, 1970.
- Heffron, Michael. "SCN Cost Control, A Discussion of Observed Problems." Washington, D.C.: Center for Naval Analysis, March 3, 1969.
- Increasing the Effectiveness of Change Cost Management in Air Force Systems Command. A Report by McKinsey and Company, Inc., June, 1965.
- Johnson, Carl A. and Tolbert, James R. "A Comparison of DOD Program Change Procedures." An unpublished thesis, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, August, 1969.
- Kanter, Herschel, Heffron, Michael and Lando, Mordechai. Influence of Forecasts of Prices and Market Conditions on Estimating and Pricing Ships. Washington, D.C.: Center for Naval Analysis, February 3, 1969.
- Kenny, Charles E. The Total Package Procurement Concept: A Few Roadblocks to Successful Implementation. Maxwell Air Force Base, Alabama: Air University, 1969.

- Launer, Robert L., Candy, Harold F. and Carter, Shirley H. Cost Growth - Effects of Contract Size, Duration, Inflation and Technology. Fort Lee, Va.: U.S. Army Procurement Research Office, May, 1972.
- Meehan, J.D. "Major Weapon System Acquisition - An Analysis of DOD Management Arrangements." Unpublished thesis, Air Force Institute of Technology, 1968.
- Osborne, George S. and Slotts, Franklin D. "An Investigation of the Application of Available DOD Sources of Cost Information Reports." An unpublished thesis, Air Force Base, Ohio, August, 1966.
- Pearce, Jack U. An Evaluation of Management Concepts in Weapon Systems Development and Acquisition Activities. Washington, D.C.: Industrial College of the Armed Forces, March 31, 1966.
- Perry, R.L., DiSalvo, D., Hall, G.R., Harmon, A.J., Levenson, G.S., Smith, G.K. and Stucker, J.P. System Acquisition Experience. Santa Monica, California: Rand Corporation, November, 1969.
- Report of Study of New Construction Costs of Major Warships. Washington, D.C.: Center for Naval Analysis, December 1, 1967.
- Report on Weapon Systems Management: F-111. Washington, D.C.; Industrial College of the Armed Forces, May 31, 1968.
- U.S. Commission on Government Procurement. Subjects Recommended by the Department of Defense for Consideration By the Commission On Government Procurement. Washington, D.C. (Mimeographed).
- U.S. Congress. House. Bibliography of Materials Relating to Government Procurement. JR 474, P1191, Commission on Government Procurement, December, 1970.
- U.S. Congress. House. "Comparison of the Estimated Cost Data as of June 30, 1972 with the Estimated Cost Data as of March 31, 1972, for 47 Weapons Systems." Report to Representative Les Aspen by the Comptroller General of the United States, November 24, 1972.
- U.S. Congress. Acquisition of Major Weapon Systems. Report to the Congress of the United States by the Comptroller General. Washington, D.C.: Government Printing Office, March 18, 1971.

- U.S. Congress. Acquisition of Major Weapon Systems.
Report B-163058 to the Congress of the United States
by the Comptroller General. Washington, D.C.:
Government Printing Office, July, 1972.
- U.S. Congress. Causes for Cost, Schedule and Performance
Variance In Acquiring Major Weapons Systems.
Report to the Congress of the United States by
the Comptroller General. Washington, D.C.:
Government Printing Office, July, 1970.
- U.S. Congress. Cost Growth in Major Weapon Systems.
Report B-163058 to the Congress of the United States
by the Comptroller General. Washington, D.C.:
Government Printing Office, March, 1973.
- U.S. Congress. Need For Improvement In Pricing of Change
Orders For Construction of Naval Vessels. Report
to the Congress of the United States by the
Comptroller General. Washington, D.C.: Government
Printing Office, September, 1969.
- U.S. Congress. The Acquisition of Weapons Systems. Hearings.
before the Subcommittee on Economy in Government of
the Joint Economic Committee, Congress of the United
States, 91st Congress, 1st Session, 1962.
- U.S. Department of Defense. Air Force Academy. Weapons
Acquisition Process Study Phase III. Colorado
Springs, Colorado: Department of Economics and
Management, U.S. Air Force Academy, March 15, 1971.
- U.S. Department of Defense. Air Force Systems Command.
Configuration Management during Definition and
Acquisition Phases. Air Force Systems Command
Manual 371-1. Washington, D.C.: Department of the
Air Force, January, 1964.
- U.S. Department of Defense. Air Force Systems Command.
Report of AFSC/AFLC AD HOC Working Group for
Management of Engineering Changes During Acquisition.
Washington, D.C.: Air Force Systems Command,
January, 1970.
- U.S. Department of Defense. Army Material Command. U.S.
Army Material Command Configuration Control Board.
Army Material Command Memorandum #15-28, dated
May 28, 1970.
- U.S. Department of Defense. "Army Procurement Research,"
Paper presented to DOD Procurement in the Seventies
Symposium, Wright-Patterson AFB, Ohio, February 23-24,
1972.

- U.S. Department of Defense. Blue Ribbon Defense Panel. Appendix E-Staff Report on Major Weapon Systems Acquisition Process, Report to the President and the Secretary of Defense on the Department of Defense. Washington, D.C.: Government Printing Office, July 1, 1970..
- U.S. Department of Defense. Blue Ribbon Defense Panel. Report to the President and the Secretary of Defense on the Department of Defense. (Fitzhugh Report), Washington, D.C.: Government Printing Office, July, 1970.
- U.S. Department of Defense. Cost Estimating for Major Defense Systems. January 25, 1972.
- U.S. Department of Defense. Configuration Management. DOD Instruction 5010.19. Washington, D.C.: Department of Defense, July 17, 1968.
- U.S. Department of Defense. Configuration Management Implementating Guidance. DOD Instruction 5010.21. Washington, D.C.: Department of Defense, August 6, 1968.
- U.S. Department of Defense. Department of the Air Force. Management of the Aircraft Procurement and Production Program. Washington, D.C.: Department of the Air Force, November, 1970.
- U.S. Department of Defense. Department of the Army. Research and Development Configuration Management. Army publication 70-37. Washington, D.C.: Department of the Army, June, 1969.
- U.S. Department of Defense. DOD Procurement Conference Report 27, 28 and 29 September 1972 Airlie House, Warrington Virginia. Washington, D.C.: Department of Defense, 1972.
- U.S. Department of Defense. Configuration Control - Engineering Changes, Deviations, and Waivers. Military Standard No 480, October 30, 1968.
- U.S. Department of Defense. Naval Material Command. Change Control. Washington, D.C. Navy Department, August 4, 1970.
- U.S. Department of Defense. Naval Material Command. "Change Orders." Naval Material Command memorandum dated November 8, 1972.

- U.S. Department of Defense. Naval Material Command. Chief of Naval Material memorandum dated October 30, 1968.
- U.S. Department of Defense. Naval Material Command. Claims Briefing Book. April, 1973.
- U.S. Department of Defense. Naval Material Command. "Constructive Change Orders." Headquarters Naval Material Command Procurement Newsletter. May-June, 1969.
- U.S. Department of Defense. Naval Material Command. Constructive Change Orders in the Navy. Chief of Naval Material memorandum dated September 3, 1969.
- U.S. Department of Defense. Naval Material Command. Control of Changes in Naval Weapon System Acquisition. Naval Material Notice 4130. Washington, D.C.: Navy Department, February 9, 1970.
- U.S. Department of Defense. Naval Material Command. "Control of Unpriced Change Order Actions in Weapons Systems Acquisition." Chief of Naval Material memorandum dated January 2, 1973.
- U.S. Department of Defense. Naval Material Command. Headquarters Naval Material Command Procurement Newsletter. May-June, 1969, pp. 1-2.
- U.S. Department of Defense. Naval Material Command. Memorandum dated April 3, 1972.
- U.S. Department of Defense. Naval Material Command. Memorandum dated December 4, 1972.
- U.S. Department of Defense. Naval Material Command. Navy Claims. Chief of Naval Material memorandum dated April 3, 1973.
- U.S. Department of Defense. Naval Material Command. Principles of Management of Changes Within the Navy. Washington, D.C.: Naval Material Command, April 13, 1971.
- U.S. Department of Defense. Naval Material Command. Procurement Circular No 15, March 6, 1970.
- U.S. Department of Defense. Naval Material Command. Procurement Circular No 18, October 27, 1970.

- U.S. Department of Defense. Naval Material Command. SCN Pricing and Cost Control Study. Washington, D.C.: Naval Material Command, April, 1969.
- U.S. Department of Defense. Naval Material Command. Segregation of Change Cost and Disruption Costs in New Ship Construction. Washington, D.C.: Naval Material Command, July 28, 1970.
- U.S. Department of Defense. Naval Material Command. Unpriced Changes. Chief of Naval Material memorandum dated November 8, 1972.
- U.S. Department of Defense. Naval Ship Systems Command. "Change Proposals to Ship Project Descriptions During Ship Detail Design and Construction/Conversion: Procedures for Submittal and Processing of." NAVSHIPS Notice 4130. Washington, D.C.: Naval Ship Systems Command, June 10, 1970.
- U.S. Department of Defense. Naval Ships Systems Command. Configuration Control for Shipbuilding Contracts. NAVSHIPS Notice 4130. Washington, D.C.: Navy Department, April 20, 1970.
- U.S. Department of Defense. Naval Ship Systems Command. "Departures from Specifications and Other Contractual Technical Documents, Procedures for Submittal and Processing of Requests for Deviations and Waivers for." NAVSHIPS Notice 4130. Washington, D.C.: Navy Department, February, 1973.
- U.S. Department of Defense. Naval Ship Systems Command. "Establishment of a Ship Cost Baseline and Control of Changes Thereto." NAVSHIPS Notice 4130. Washington, D.C.: Navy Department, February 1, 1971.
- U.S. Department of Defense. Naval Ship Systems Command. "Non-Engineering Change Proposals (NECP's), Instructions for Use and Preparation of." NAVSHIPS Notice 4130. Washington, D.C.: Navy Department, October 16, 1970.
- U.S. Department of Defense. Naval Ship Systems Command. "MIL-STD-480 Configuration Control - Engineering Changes, Naval Ship Application." NAVSHIPS Notice 4130. Washington, D.C.: Navy Department, April 21, 1970.
- U.S. Department of Defense. Naval Ships Systems Command. Plan for Promulgation of Ship Configuration Management and Change Control Manual. NAVSHIPS Notice 4130. Washington, D.C.: Navy Department, April 17, 1970.

- U.S. Department of Defense. Naval Ships Systems Command.
"Report Concerning Procurement Practices and Cost
Controls at EBD, Proton." Washington, D.C.:
Navy Department, April 30, 1970.
- U.S. Department of Defense. Naval Ships System Command.
"Ship Project Change Control: Establishment of
Change Control and Change Review Boards." NAVSHIPS
Instruction 5420.9B. Washington, D.C.: Navy
Department, May 7, 1969.
- U.S. Department of Defense. Naval Ships System Command.
"Specifications Control Board and Cost-Benefit
Analysis Procedures." NAVSHIPS Notice 4121.
Washington, D.C.: Navy Department, March 6, 1972.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Comptroller). Distribution
of Cost Growth by Category. December, 1972.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Comptroller). MILITARY PRIME
CONTRACT AWARDS - SIZE DISTRIBUTION FISCAL YEAR 1972.
Washington, D.C.: Government Printing Office, 1972.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Comptroller). THE ECONOMICS
OF DEFENSE SPENDING - A LOOK AT THE REALITIES.
Washington, D.C.: Government Printing Office,
July, 1972.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Installation and Logistics).
Audit Review 71-1. Washington, D.C.: Government
Printing Office, July, 1970.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Installation and Logistics).
"Cost Estimating for Major Weapon Systems."
Assistant Secretary of Defense memorandum dated
November 29, 1971.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Installation and Logistics).
Review of Audit Reports and Studies on Engineering
Change Proposals and Modifications. A report
dated November 20, 1970.
- U.S. Department of Defense. Office of the Assistant
Secretary of Defense (Installation and Logistics).
Review of Engineering Change Proposal Processing
Procedure. Washington, D.C.: Department of
Defense, March 14, 1963.

- U.S. Department of Defense. Office of the Assistant Secretary of Defense (Systems Analysis). Letter dated February 1, 1972.
- U.S. Department of Defense. Office of the General Counsel of the Navy. Memorandum dated August 6, 1969.
- U.S. Department of Defense. Office of the General Counsel of the Navy. Recurring Configuration Control Problems. Paper presented October 23, 1970.
- U.S. Department of Defense. Office of the Under Secretary of the Navy. "Cost Estimating." Under Secretary memorandum dated February 23, 1971.
- U.S. Department of Defense. Performance Measurement for Selected Acquisitions. DOD Instruction 7000.2, December 22, 1967.
- U.S. Department of Defense. Selected Acquisition Reports (SAR). DOD Instruction 7000.3, December 19, 1969.
- U.S. Department of Defense. The Development of Management Control Systems for Use in the Acquisition Process. DOD Instruction 7000.2, June 6, 1968.
- Waterman, Bernard S. The C5A - A Study of the Weapons System Acquisition Process. Washington, D.C.: Industrial College of the Armed Forces, February, 1969.
- Wehr, William I. and Woodard, Wendell O. "Cost Optimism: An Outgrowth of the Defense Industry Environment." An unpublished thesis, Air Force Institute of Technology, Air University, Wright-Patterson Air Force Base, Ohio. February, 1971.
- The 1967 DOD-WIDE Procurement Pricing Conference. Proceedings of Panel No. 12 Change Order Pricing. Hersey, Pa., 1967.

PERIODICALS

- Aspin, Les. "The Lockheed Loan Revisited." The New York Times, August 29, 1972, pp 33.
- Avots, Ivars. "Why Does Project Management Fail?" California Management Review, Fall, 1969, pp. 77-82.

- Booda, Larry. "Faith, Patience, Perseverance and the Tom Cat." Sea Power, March, 1972, pp. 13-18.
- Borkland, C.W. "Defense Procurement: Trends and Myths." Government Executive, January, 1970, pp. 62-64.
- Bunker, William B., Lieutenant General, USA. "Objectives of Configuration Management." Defense Industry Bulletin, September, 1967, pp. 1-3.
- "Contract Procedures Cause Cost Overruns." Industrial Research, August, 1969, pp. 35-37.
- "Debate Flares Over B-1 Bomber Costs." Washington Post, March 8, 1973, p. C7.
- Derscha, Julius. "The Costly Mysteries of Defense Spending." Harpers, April, 1964, pp. 59-65.
- Drake, Hudson. "Major DOD Procurement at War with Reality." Harvard Business Review, January-February, 1970, pp. 119-140.
- Engoran, Edward J. and Jackson (Jr.), Albert L. "Uniform Policy and Guidance Established for Configuration Management." Defense Industry Bulletin, January, 1969, pp. 1-4.
- Feyereisen, Paul A. "Program Refinement of Material Acquisition Process-70." Defense Industry Bulletin, August, 1970,
- Getler, Michael. "David Packard: Presiding Over a Revolution." Armed Forces Management, March, 1970, pp. 24-29.
- Griffiths, Kenneth and Kanzaki, George A. "The Technical Data Package and Competitive Procurement." Defense Management Journal, April, 1972, pp. 17-21.
- "Grumman Told to Produce F-14's." Washington Post, March 2, 1973, pp. A1-A6.
- "Lockheed Answers C-5 Programme Criticisms." Interavia, Vol. 24, August, 1969, pp. 1034-1035.
- "Missiles on the Carpet." Economist, March 5, 1970, p. 921.
- Packard, David. "The Weapons Acquisition Process: Policy and Prospective." Defense Management Bulletin, Fall, 1971, pp. 2-7.

- "Packard Guidelines on Major Weapon System Acquisition."
Armed Forces Journal, June 13, 1970, pp. 22-23.
- Podnos, S.S. "A Critique of Weapon Systems Management."
The GAO Review, Spring, 1970, pp. 10-15.
- Powell, Craig. "S-3A: Test Run for DOD's Milestone
Procurement Concept." Armed Forces Management,
December, 1969, pp. 36-38.
- "Price Rise Seen for Navy F-14." Washington Post, June 20,
1973, p. 10.
- Reda, Frank. "Impact Costs of Acceleration." Federal Bar
Journal, Vol. 25, Spring, 1965, pp. 239-247.
- Shillito, Barry J.. "Management of Major Weapons System
Acquisition." Defense Industry Bulletin, January,
1970.
- Seamans, Dr. Robert A., Jr. "Solving Procurement Problems."
Defense Management Journal, Fall, 1969, pp. 205.
- Sppektor, Louis. "An Analysis of the Standard 'Changes'
Clause." Federal Bar Journal, Vol. 25, Spring,
1965, pp. 177-194.
- "Technical Data Management is Costly, Continuous Problem."
Government Executive, December, 1969, pp. 58-60.
- "The Name of the Game is Management of Change." Armed
Forces Management, October, 1969, pp. 75-79.
- "U.S. Will Halt Output of F-111 Late in 1974." Washington
Post, June 7, 1973, p. C8.
- Waks, Norman. "Current Issues in Military Program Control."
IEEE Transactions on Engineering Management, August,
1970, pp. 92-101.
- William Seith, Captain, USN. "Configuration Management
in the Navy." Defense Industry Bulletin, April,
1967, pp. 1-12.

MISCELLANEOUS

- Aerospace Industries Association. Essential Technical
Steps and Related Uncertainties in DOD Weapon Systems
Development, Phases I thru IV. Washington: Aerospace
Industries Association. December, 1970.

Broyles, George David. "An Analysis of Cost Growth in Aerospace Weapons Systems Programs." Unpublished dissertation, University of Alabama, 1972.

Change Management - Control of Engineering and Design Changes. Washington, D.C.: Logistics Management Institute, November 10, 1965.

Dellis, Donald O. "An Analysis of Cost Growth and Its Causes in Major Weapon System Acquisitions." Unpublished MBA thesis, The George Washington University, 1971.

Faleskie, Thomas J. "The Factors of Cost Overrun in The Weapon Acquisition Process." Unpublished MBA thesis, The George Washington University, 1970.

"F-14 Overruns on Costs." Letter from William M. Zarkowsky, President, Grumman Aerospace Corporation, to Rear Admiral E.E. McMorries, Contracting Officer, Naval Air Systems Command, dated March 31, 1971.

Gold, Harold, Gaskins, John W., Rebakoff, Sol and Whitesell Carlin H. Changes and Changed Conditions. Government Contracts Monograph No. 3. The George Washington University in cooperation with Federal Publications Inc. Washington, D.C., 1962.

Head, Richard Glenn. "Decision-Making On the A-7 Attack Aircraft Program." Unpublished dissertation, Syracuse University, January, 1971.

Increasing the Effectiveness of Change Cost Management in the Air Force System Command. Washington, D.C.: McKinsey and Company, Inc., June, 1965.

Letter from the Assistant Secretary of Defense Shillito to the Council of Defense and Space Industries (CODSIA), October 8, 1970.

Letter from the Council of Defense and Space Industrial Association (CODSIA) to the Assistant Secretary of Defense Shillito, September 1, 1970.

Lorette, Richard J. "The Relationship Between Pressures on the System Program Director and the Growth of Weapon System Cost Estimates." Unpublished DBA dissertation, Harvard University, 1967.

- McAdams, William M. "Controlling Changes in Major Defense Procurement Contracts." Unpublished MBA thesis, The George Washington University, 1972.
- Mills, Hubert Preston. A Critical Review and Appraisal of the Organization, Practices, and Policies of the USN in the Management of Aeronautical Engineering Changes (Mods) to Weapons Systems and Equipment. An unpublished DBA dissertation, The George Washington University, April, 1970.
- National Security Industrial Association. Defense Acquisition Study. Washington: National Security Industrial Association, July 1, 1970.
- O'Keefe, Richard Dennis. "Configuration Management As Implemented By The Department of Defense: An Analysis." Unpublished MBA thesis, The George Washington University, February, 1970.
- Reece, James S. "The Effects of Contract Changes on the Control of a Major Defense Weapon System Program." Unpublished DBA dissertation, Harvard University, 1970.
- Report of the Committee of Inquiry into the Aircraft Industry. London: Her Majesty's Stationary Office, December, 1965.
- Schloeman, Howard L. "Controlling Cost Overruns In Weapon System Acquisition." Unpublished MBA thesis, The George Washington University, 1970.
- Study and Control of Cost Overruns. Princeton, N.J.: Mathematica. March, 1970.
- Summary of AIA Weapon Systems Development Project. Washington, D.C.: Aerospace Technical Association, December, 1970.
- Washburne, William K. "Configuration Management." Unpublished MBA thesis, The George Washington University, 1972.

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