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AN APPRAISAL OF THE SHORT-TERM COST RESULTS OF
A SELECTED NUMBER OF AIR FORCE SHOULD COST STUDIES

William E. Schaefer, et al

Air Force Institute of Technology
Wright-Patterson Air Force Base, Ohio

August 1975

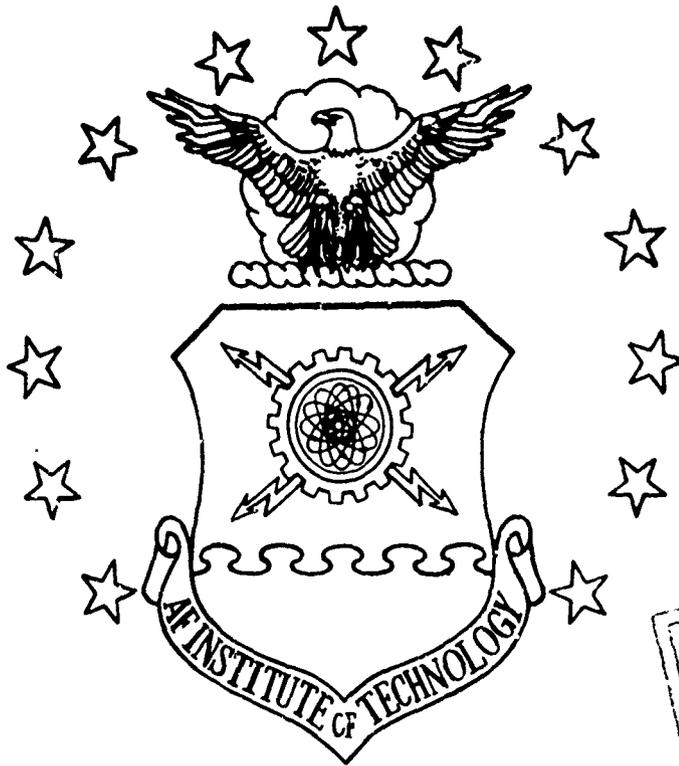
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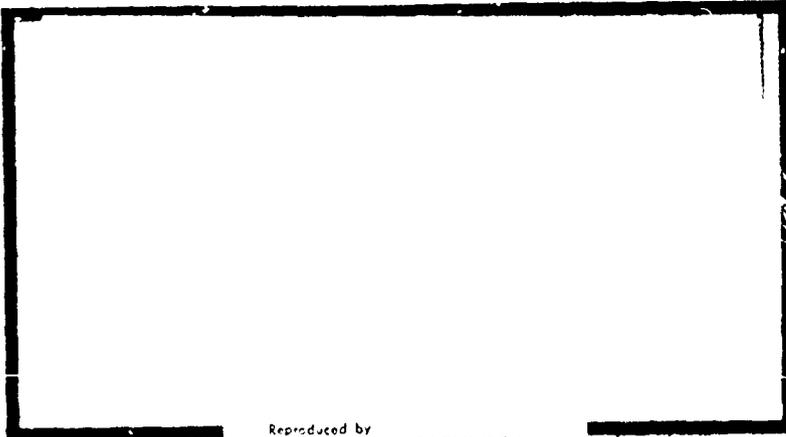
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OF AIR FORCE SHOULD COST STUDIES

William E. Schaefer, Lt. Colonel, USAF
Roy F. Birkhead, Major, USAF

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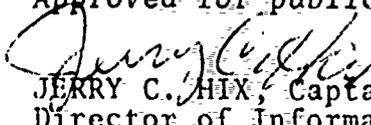
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Should Cost briefly can be described as a technique of contract pricing which seeks to determine a realistic price objective which reflects reasonably achievable economies and efficiencies of contractor operations. The Air Force has performed a number of Should Cost studies, each with the stated objective of achieving the desired results contemplated by the above definition. Has the Air Force achieved these results? Up to this point, this question has not been easily answerable since the final cost outcomes have not been available as a basis against which originally negotiated cost targets could be compared. This research has used the results of four essentially completed contract efforts, which were originally negotiated using the Should Cost approach, in an attempt to evaluate the real effectiveness of Should Cost. Based upon a limited sample of four contracts which were negotiated using the Should Cost technique, the study showed that Should Cost, as used by the Air Force, may be producing results which are not more effective than those experienced from contracts negotiated using conventional cost analysis.

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SELECTED NUMBER OF AIR FORCE
SHOULD COST STUDIES

A Thesis

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the
Degree of Master of Science in Logistics Management

By

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Lieutenant Colonel, USAF
(Logistics Management,
Procurement Major)

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August 1975

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Lieutenant Colonel William E. Schaefer
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and

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

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

DATE: 13 August 1975

Martin D. Martin
COMMITTEE CHAIRMAN

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Chapter 1

INTRODUCTION

Statement of the Problem

As the complexity of weapons systems increased during the 1960s, it became more difficult to accurately estimate the related acquisition costs, both in the early development and production phases of the acquisition cycle (8:7). Faulty cost estimates, coupled with inflation, were blamed as causing numerous projects to experience significant cost growth and schedule delays (8:7). In response to this problem, the Department of Defense (DOD) initiated several activities designed to improve its cost estimating capabilities for Government contracts. One of the approaches developed was a concept called Should Cost.

To establish a common baseline for departure and deal in more specific terms, the following definition of Should Cost which was developed by the U.S. Air Force (22:1-1) is set forth:

Should Cost. A technique of contract pricing that employs an integrated team of Government procurement, contract administration, audit, and engineering representatives to conduct a coordinated, in-depth cost analysis at the contractor's/sub-contractor's plants. The objective is to identify uneconomical or inefficient practices in the contractor's management and operations and to quantify the findings in terms of their impact on cost. The

result is the development of a realistic price objective which reflects reasonably achievable economies and efficiencies.

A total of twenty-three Should Cost studies were conducted by ASD during the calendar year period 1971 through 1974 (3:3). These twenty-three studies demonstrate that Should Cost has been used discriminantly by ASD as a cost analysis/negotiation tool (3:3). The results of these Should Cost reviews have proven beneficial to the extent that they have supported negotiation positions maintained by Air Force contract negotiators. A survey of articles and research works pertaining to Should Cost indicates that the literature deals primarily with the methodological and organizational aspects of applying the Should Cost technique in the procurement environment. Many of these studies presuppose that the application of the Should Cost technique produces lasting contractual cost savings to the Government. While offering some valuable insights into the usefulness of Should Cost, the literature at the same time generally overlooks the vital matter of the validity of cost savings as highlighted by Wayne M. Allen (1:48).

The Should Cost philosophy has the admirable goal of obtaining for the Government optimal efficiency in contractor operations. However, as a practical matter there are some difficulties. The buyer is prepared to tell the seller how the seller should conduct his business. . . . While this is an oversimplification, the fact remains that under Cost Plus contracting procedures the buyer generally assumes responsibility for most of the costs. Thus, the claims we

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

In summary, the initial results of Should Cost studies have shown that the application of the Should Cost analysis technique does offer potential but unproven contract cost savings (3:3). The problem then, is whether the contract cost savings are real and lasting or whether they are a short-lived phenomena manifested by lowered negotiated contract cost targets, only to find the final contract costs or profits paid by the Government to be higher than those originally contemplated.

Significance of the Problem

The continued application of the Should Cost technique without a sound assessment of its effectiveness can have an adverse effect upon the Air Force's stated policy of selected usage (22:1-1). The Should Cost concept as employed by the Air Force may require substantial personnel and travel expense; thus, unwise Should Cost application could result in dissipation of critical personnel resources and the incurrence of unwarranted costs (22:1-1).

Background

Should Cost explained. Cost analysis is an inherent element of the Should Cost technique. The Armed Services Procurement Regulation (ASPR) defines cost analysis, as it relates

to Government procurement transactions, as . . . (21:13):

. . . the review and evaluation of a contractor's cost or pricing data and of the judgemental factors applied in projecting from the data to the estimated costs, in order to form an opinion on the degree to which the contractor's proposed costs represent what performance of the contract should cost, assuming reasonable economy and efficiency.

Some of the present day methods of cost analysis are:

1. The historic method where the estimate is based on previous procurements of similar items;
2. The engineering or building block approach which entails an examination of separate items of work at a low level of the work breakdown structure with detailed estimates developed for functional costs of engineering, manufacturing, quality control, etc., which are in turn sub-categorized by labor, material, and other cost estimates;
3. The parametric costing technique predicts costs by means of explanatory variables such as performance characteristics, physical characteristics, and characteristics relevant to the development process as derived from experience on related systems; and
4. The Should Cost approach which seeks to develop a realistic price objective by quantifying the impact on cost of inefficient or uneconomical practices in the contractor's management and operations.

This Should Cost concept is not new. It is, or should be, an inherent aspect of each contract cost analysis performed. What is relatively new is the manner in which the concept is applied using highly specialized teams of individuals (either independent consultants and/or DOD employees) to perform the in-depth analyses of contractors' operations (22:1-1). A Should Cost review considers all activity in a contractor's plant; however,

usually it is conducted in connection with the cost analysis of one program or product.

Should cost differs from traditional pricing primarily in two respects: (1) depth of analysis; and (2) extent to which the Government challenges inefficiencies in contractor operations (16:20). Traditional pricing efforts are based largely on projections of historical cost data. When past operations were inefficient, such projections of cost data included an automatic "built-in" factor covering the cost of continued inefficiency (11:3). Through careful analysis, these inefficient practices can be discovered in contractors' current proposals (11:4). The Air Force can then be reasonably assured that only those costs which would be incurred under conditions of economy and efficiency of operations will be incurred (11:4).

Objectives of Should Cost. The Government hopes to accomplish two important objectives by performing Should Cost analyses (11:4). The first is to establish a Government negotiation position (11:4). Corollary to this goal is the hoped-for short-term benefits which are those savings to be accrued by the Government during the instant contractor's period of performance (22:2-2). It should be emphasized that the Should Cost figure may not be one which

is attainable, but one which reflects the dollar effect of achievable economies and efficiencies (11:4).

The second objective is to encourage and assist the contractors in becoming more efficient (16:23). This benefits not only the Government, but the contractor as well, since it improves the contractor's ability to compete (15:23). The long-term benefits to the Government are the potential savings resulting from the contractor's management improvements which could apply either to follow-on procurements or to other product lines (22:2-2).

Commitments are obtained from the contractor's top management to correct specific inefficient practices which are identified through Should Cost reviews (15:21). A few of the specific management areas which have been brought to contractors' attention as a result of past Should Cost reviews are: (1) improve or establish direct labor standards ; (2) reduce scrap; (3) improve a make-or-buy system; (4) improve plant layout; and (5) improve production management (11:5).

Based on experience to date, Should Cost offers a noteworthy capability for obtaining a better understanding of the contractor's operation which, in turn, can be translated into a more comprehensive evaluation of costs proposed to the Government (22:1-1). The Should Cost approach, as used by the Government, is not viewed as a cure-all to "cost growth" or "cost overruns." To avoid

confusion, these terms will be explained at this point (5:364-365):

Cost overrun is that sum of money spent on a program in excess of contract price.

Cost growth is the increase in program expenditures above the price of the original program plan.

However, Should Cost is viewed as a potent analytical tool for use in those cases which meet the Should Cost application criteria (22:1-1).

Criteria for Should Cost application. The Air Force position states the Should Cost technique should be used in those selective instances where the Air Force can anticipate a major payoff by its application (20:2-1). The Air Force has found, ideally, that Should Cost reviews are most productive when employed on procurements: (1) for which there are future year production requirements for substantial quantities of like items; (2) there has already been some production--in all probability, the initial production run; (3) a sole-source situation exists; (4) the specifications are comparatively definitive; and (5) the present and potential value of the work is substantial (22:2-1). It is Air Force policy that virtually all situations involving continuing procurement of items from a sole-source contractor should be considered as candidates for new Should Cost studies (22:2-1).

The Air Force applies the following general criteria in the selection of procurements for Should Cost reviews (22:2-2):

1. Major On-Going System. Optimum results should occur when the contractor's procedures for quality production have been established. Under these circumstances, inefficiencies and uneconomical practices may be identified and the impact of their correction measured.

2. Imminent Follow-on Buy. An imminent follow-on buy may exist which will provide opportunity for correction of inefficiencies and uneconomical practices potentially resulting in future cost reductions.

3. Cost Effectiveness. The relationship between the potential savings which may accrue to the Government and the cost of conducting a Should Cost analysis is of major importance. The possibility for savings should be commensurate with the effort involved.

4. History of Increasing Costs. Trends of increasing costs for the acquisition of the same system, subsystem, or component generally are indicative of a situation where Should Cost can be used productively.

5. Preponderance of Government Business. Where the contractor's business is predominantly Government rather than commercial, competitive forces may not be significant enough to encourage good cost controls.

The appropriate timing for the application of a Should Cost review is debatable, but, since the technique is highly product-oriented, it would probably become more justified as the product advances through the system life cycle and the number of uncertainties decreases.

Elements of analysis. The elements of analysis encompassed in the Should Cost study are directed at a quantitative evaluation of the contractor's proposal and operations (10:5-1). The analysis of the contractor's manufacturing operations is vital to the success of the Should Cost review as it represents the realistic baseline upon which the ultimate cost objective is developed (22:5-1). Therefore, the depth and extent of analysis of the manufacturing operations is carefully planned and monitored to ensure results which apply to the specific contract under evaluation and effective use of the team members (22:5-1). The objective of the manufacturing operations evaluation is to identify uneconomic or inefficient practices and quantify the findings in terms of their impact on cost so as to develop a realistic price objective for negotiation (22:5-1). The negotiation objective is a price at which it is believed/predicted that the contractor can produce if he operates with reasonable economy and efficiency (11:5). The Government does not seek to tell a contractor how to run his business. It does, however, have a

commitment to the American taxpayer not to pay for inefficient practices in the acquisition of major weapons systems (11:5).

Previous Studies

Since 1970, the popularity of Should Cost has grown significantly and numerous articles and research works on the subject of Should Cost have been published. A review of this literature by the researchers revealed that it dealt generally with the application of the "how" and "by whom" mechanics of the Should Cost technique or suggesting another way of applying it. There was evidence of quantitative research into the cost results of Should Cost studies. However, the scope of the research was limited to quantitative analyses of the comparisons of proposed costs and negotiated costs showing the resultant improvements in negotiation position to validate the application of the Should Cost technique. This limitation in scope can be attributed to the state of available cost data at the time of the research.

As the work under contracts negotiated using Should Cost nears completion, data relating to actual contract costs becomes available. It is believed that a more in-depth quantitative analysis of the impact of Should Cost on costs over the life of the contract is in order.

Objective

The primary objective of this research study was to quantify the comparison of contract cost outcomes on Should Cost negotiated contracts with those contracts negotiated using conventional cost analysis techniques.

Scope

This research effort was concerned with Air Force conducted Should Cost reviews. The study was confined to the Aeronautical Systems Division (ASD) of the Air Force Systems Command.

As mentioned earlier, the primary objective of this research study was to quantify the comparison of contract cost outcomes on Should Cost negotiated contracts versus those negotiated using conventional cost analysis techniques. To accomplish this objective, the criteria examined were limited to cost data elements which were quantitatively measurable. Those qualitative criteria such as long range management improvement recommendations, which generally can only be indirectly measured, were excluded and are addressed in the Summary List of Assumptions/Limitations.

Research Hypothesis

There is a difference between the actual cost outcomes on contracts negotiated using Should Cost methods and

the actual cost outcomes on those contracts negotiated using conventional cost analysis techniques.

Chapter 2

SHOULD COST STUDIES: AERONAUTICAL SYSTEMS DIVISION

The content of this chapter is intended to provide a general understanding of the environment, conditions, and criteria underlying Should Cost activity in the Aeronautical Systems Division (ASD) and to set the stage for the reader's understanding of the research performed, the results of which are presented in the following chapters.

The Aeronautical Systems Division of the Air Force Systems Command (AFSC) plans and manages the acquisition of aeronautical systems, subsystems, and associated equipment (4:1). ASD is directly responsible to Headquarters AFSC for mission accomplishment. Within this mission responsibility, ASD enters into contracts and manages all phases of procurement and production in support of such diverse products as major weapon systems, research and development, services, Aerospace Ground Equipment (AGE), aircraft engines and supplies (4:1). ASD is organized on a functional and projectized basis to perform this mission responsibility. The Directorate of Pricing within the Deputate of Procurement and Production has the primary responsibility for managing Should Cost

activities in the ASD organization. ASD has been very selective in the application of Should Cost (4). This selective application is in consonance with the overall Air Force policy which advocates selective usage of the technique, thus avoiding excessive and disruptive expenditures of manpower and personnel resources (22:1-1). The physical performance of the Should Cost review by ASD is conducted by a team which is structured to meet the needs of a specific procurement (4). The selection of team members is critical to the success of the activity; therefore, ASD strives to achieve a balance of disciplines on each team to assure a broad, but adequate coverage of functional activities. The team chief, who generally is a senior management individual, is responsible for the overall Should Cost operation from the planning phase to final contract negotiation and documentation (4). The procuring contracting officer (PCO) serves in his normal contracting role while the price analyst operates normally as the chief negotiator (4).

In performing the Should Cost studies, ASD has the objective of producing significant efficiencies and dollar savings (4). ASD views the Should Cost technique as an extension of the cost analysis method for analyzing contractor cost proposals (4). This extended cost analysis concept involves a greater than normal analysis of the proposal cost elements; however, an in-depth industrial

engineering evaluation of the processes which drive the cost incurrence actions may not be made. It can be argued that normal cost analysis may provide the same benefits available through Should Cost. ASD, however, believed that the insights gained from the in-depth cost analysis reviews as performed by them could achieve negotiated reductions comparable to those performed under a highly structured Should Cost review which relies on an industrial engineering approach to the analysis (4), and better than that achieved from a normal cost analysis.

As previously mentioned, ASD performed twenty-three Should Cost studies during the calendar year period April 1971 through 1974. As a means for evaluating the effectiveness of these studies where Should Cost was used versus cases where normal cost analysis was used, ASD made a study, the results of which are shown in Table 1. Rather than discuss the details of the data in the table, emphasis is placed on ASD's ability to sustain 67.5 percent of a proportionately larger (24.4 percent) proposed reduction amount. Although the 67.5 percent is less than the 73.9 percent sustained reduction as a result of normal cost analysis, the dollar return potential under Should Cost is much greater due to the higher proposed reduction amount of \$149.9 million. It should be noted that the contractors selected by ASD for the comparative review were not comprised of identical contractors as

Table 1
 COMPARATIVE RESULTS OF PROPOSAL ANALYSES
 USING SHOULD COST AND NORMAL COST ANALYSIS
 (Cost \$ in Millions)

| | <u>Should Cost</u> (12 Cases) | <u>Normal Cost Analysis</u> (15 Cases) |
|--------------------------------------------------------------------|----------------------------------|-----------------------------------------------|
| Contractor Proposed | \$613.2 | \$539.3 |
| Air Force Objective | <u>463.3</u> | <u>494.8</u> |
| Proposed Reduction | \$149.9 (24.4%) | \$ 44.5 (8.3%) |
| Contractor Proposed | \$613.2 | \$539.3 |
| Negotiated | <u>512.0</u> | <u>506.4</u> |
| Reduction | \$101.2 (16.5%) | \$ 32.9 (6.1%) |
| Percent of Objective Reduction Dollars Sustained in Negotiation | 67.5% | 73.9% |

Source: ASD Briefing and ASD Records.

those included in the Should Cost sample and those in the normal cost analysis sample. The different mix of contractors, reviewed in this study, could have biased the data statistically resulting in a distortion of proposed reductions. These reductions were 24.4 percent and 8.3 percent respectively for those analyses where Should Cost and normal cost analysis were used. The ASD statistical data was mentioned above principally to establish one convenient baseline from which ASD measured its Should Cost study effectiveness. The data was not used during this research other than to familiarize the reader with the scope of the ASD Should Cost activity. Accordingly, further analysis to establish the validity or nonvalidity of the ASD data was not made herein.

As previously stated, ASD conducts its Should Cost studies as an extension of the cost analysis method for analyzing contractor cost proposals (4). There is opportunity cost associated with achieving the benefits provided through the extended cost analysis efforts. This "extended" approach, based on the ASD experience, represented the deployment of as few as three skilled specialists to as many as nineteen. The labor and related supportive costs associated with the twenty-three ASD Should Cost studies are shown on Table 2. This table has been presented merely to reflect some historical data which may give the reader of this thesis an appreciation for the

Table 2
 COST TO CONDUCT SHOULD COST STUDIES
 (\$ In Thousands)

| Fiscal Year | Nr. Studies | Normal Sunk | Extended | Total | Average Yearly Cost | Nr. Follow-on Studies |
|-------------|-------------|-------------|----------|---------|---------------------|-----------------------|
| 1972 | 7 | \$117.9 | \$182.3 | \$300.2 | \$42.9 | -0- |
| 1973 | 6 | 93.0 | 73.4 | 166.4 | 27.7 | 3 |
| 1974 | 7 | 81.8 | 49.4 | 131.2 | 18.7 | 5 |
| 1975 | 3 | 23.7 | 32.6 | 56.3 | 18.7 | 1 |

Source: ASD Briefing and ASD Records.

additional cost involved in conducting the ASD Should Cost program. The costs are displayed to reflect those additive costs associated with the "extended" portion of the cost analysis effort and those "sunk" costs associated with the normal cost analysis. Although no detailed analysis was made to ascertain the validity of the cost data, a cursory analysis was made by the researchers to explain the decreasing average cost, by year, for the Should Cost studies conducted. Basically, the decreasing average cost could be attributed to the fact that nine follow-on studies were conducted in fiscal years 1973, 1974, and 1975, and for each study, there were fewer team members than on the previous study, thus the reduced salary and travel costs.

ASD supports the precept that Should Cost is a joint responsibility of the Procuring Contracting Officer (PCO) and the Administrative Contracting Officer (ACO) (8). In this regard, it is recognized that Should Cost reviews most generally will produce not only short-term findings which affect current negotiations of an instant procurement but will produce management and production improvements that will result in long-term economy of operations and future cost avoidance (22:7-2). Accordingly, ASD encourages each PCO to advise the responsible contractor and ACO, by letter, of the recommendations and request that appropriate action be taken to assure corrective action and continued surveillance (9).

Chapter 3

METHODOLOGY

The material presented in this chapter describes and explains the logic used to develop the statistical tests presented in Chapter 4. The discussion centers around five main sections: testing of the research hypothesis; preliminary data investigation; definition and measurement of a population; data collection; and listing of assumptions and limitations.

Testing the Research Hypothesis

The research hypothesis to be tested was:

There is a difference between the actual cost outcomes on contracts negotiated using Should Cost methods and the actual cost outcomes on those contracts negotiated using conventional cost analysis techniques.

Here the question to be analyzed was whether the differences between the samples of Should Cost contracts and conventional cost analysis contracts, in cost outcomes at various stages of contract activity, were statistically "significant." In this case, statistical significance means that enough data have been collected and analyzed in the sample to establish that differences do exist in the cost outcomes between the populations of Should Cost and non-Should Cost contracts.

Classical hypothesis testing methods were used to test the research hypothesis. Statistical hypotheses were formulated from the stated research hypothesis. The basic assumption or hypothesis was that there is no difference between the cost outcomes of the two populations of contracts. This hypothesis is called the "null hypothesis" (H_0) and is the basic hypothesis to be tested. The research hypothesis or the assumed condition that there is a difference between the two contract populations is referred to as the "alternate" hypothesis (H_1). If the statistical hypothesis testing determines that the null hypothesis cannot be rejected, then the research hypothesis is not supported by the data. Likewise, if the testing determines that the null hypothesis can be rejected, then the research hypothesis is supported by the data at the particular level of testing.

The statistical hypothesis testing was accomplished by comparing the differences of like data elements (cost outcomes at various stages of contract activity) in the two sample contract groups (paired by contractor) to determine if differences were significant so that a decision could be made to either reject (statistically significant) or not reject (not statistically significant) the null hypothesis).

The decision to reject or not reject the null hypothesis was based on treating the differences between

like data elements in the two paired contract sample groups as a single sample and calculating the average difference (\bar{D}) of each sample. The \bar{D} was then used to construct a ninety-five percent confidence interval for the average difference (Δ) between the same data elements in the population of contracts from which the sample was taken. The formula used to compute the confidence interval was as follows (23:172):

$$\text{C.I.} = \bar{D} \pm t_{.025} \frac{S_D}{\sqrt{n}}$$

where \bar{D} is the mean or average difference between like data elements in each of the two paired sample groups; $t_{.025}$ is the critical value pertaining to the upper and lower tail of the "t" distribution and obtained from an appropriate statistical table of values; S_D is the standard deviation of the individual differences from \bar{D} ; and n is the number of observations in each sample.

The confidence interval is a range of values and is an interval estimate of the population parameter Δ using the sample statistic \bar{D} and making an allowance for sampling error.

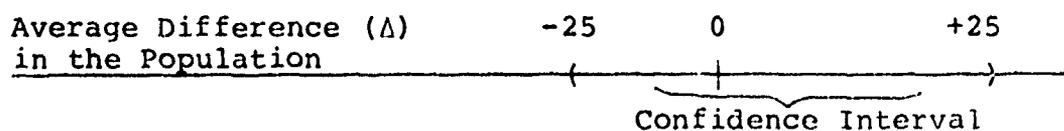
The statistical null hypothesis was that there is no difference in cost outcomes between the two contract population groups; i.e., Δ would be equal to zero, indicating no difference existed. The alternate hypothesis

stated that there is a difference between the cost outcomes of the two groups, thus Δ would not equal zero, indicating either a positive or negative difference existed. The null and alternative hypotheses can be symbolized as follows:

Null Hypothesis $H_0: \Delta = 0$

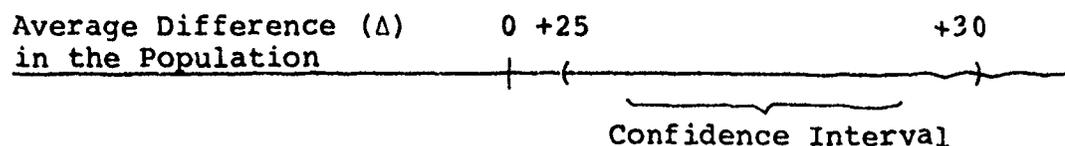
Alternate Hypothesis $H_1: \Delta \neq 0$.

If the confidence interval computed for the average difference in the population (Δ) encompasses zero, the the hypothesized value for Δ , as graphically represented below, then the null hypothesis cannot be rejected. It could be concluded from the sample that the population average difference was zero indicating no difference between the two groups of contracts (Should Cost versus non-Should Cost). Therefore, the research hypothesis would not be supported.



CANNOT REJECT NULL HYPOTHESIS

If the confidence interval for Δ excludes the hypothesized value of zero, as shown below, then the null hypothesis can be rejected. Therefore, the research hypothesis would be supported.



CAN REJECT NULL HYPOTHESIS

Hypothesis testing may be conducted at varying levels of risk. The ninety-five percent confidence level (or five percent significance level) was arbitrarily chosen by the researchers to test the null hypothesis.

Preliminary Investigation

The previously stated research hypothesis to be tested was:

There is a difference between the actual cost outcome on contracts negotiated using Should Cost methods and the actual cost outcome on those contracts negotiated using conventional cost analysis techniques.

To evaluate this hypothesis, a preliminary investigation was conducted at the Aeronautical Systems Division (ASD), Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. This preliminary investigation was concerned primarily with the availability of data for use during the later research work. The initially conceived approach for the preliminary investigation was to make a comparative analysis of completed contract costs incurred under contracts of the same general scope and product class, with the same contractor, which were negotiated using Should Cost and completed costs of those contracts negotiated by using conventional cost analysis techniques.

During this preliminary investigation, it was learned that initial negotiated contract cost data were available within the ASD Directorate of Pricing Office and that final contract costs were available from other sources. Those sources included the ASD System Program Offices as well as both Government and contractor-prepared contract cost reports. The investigation also indicated that ASD, during the calendar year period 1971 through 1974, had conducted twenty-three Should Cost studies. Of these twenty-three contracts, the two contracts listed below were selected to be included in the preliminary investigation. These two contracts were selected because the data available at the time indicated that the contract work was approaching completion, hence a situation where the desired data should be available to the researchers.

| <u>Contractor (Coded)</u> | <u>Type Contract</u> | <u>Fiscal Year</u> |
|---------------------------|-----------------------|--------------------|
| #3 | Fixed Price Incentive | FY72 |
| #6 | Fixed Price Incentive | FY73 |

As a basis for comparison of the above Should Cost negotiated contract costs versus those negotiated using conventional cost analysis techniques, two contracts negotiated using conventional cost analysis techniques during fiscal years 1971 and 1972 respectively, with the same companies, and for the same products (missiles), were selected for comparative review. The objective of the review was to

determine percentage negotiated cost reductions using conventional cost analysis (non-Should-Cost) techniques which in turn would be used as the basis of comparison for negotiated cost reductions using the Should Cost method.

However, the researchers were unable to obtain the required cost data in the time frame allotted for the preliminary investigation. Therefore, rather than pursuing a review of the data to ascertain percentage negotiated cost reductions, the investigation turned to the review of completed contract cost results for seven of those contracts negotiated using the Should Cost method. The reason for this review was to assess the status of completed contract costs as a means for identifying and/or selecting the data to be used in the research study to be performed later.

To set the stage for the later research work, the preliminary investigation was concerned with not only the availability, by contract, of total cost data, but also the availability of sub-element cost data in the format shown on the DD Form 633, "Contract Pricing Proposal," Appendix A. By a review of four Price Negotiation Memoranda, an administrative document for recording the results of contract negotiations, it was learned that cost data by sub-element as presented on the DD Form 633, i.e., Direct Material, Direct Labor, and Indirect Costs generally were neither readily available nor readily reconcilable to the format essential to the contemplated research approach.

The researchers attribute this condition to the fact that the contract work was not yet completed on three of these four contracts. Therefore, inasmuch as interim cost progress reporting was not available at the sub-element cost level of detail, the contemplated research comparisons of sub-element costs between contracts negotiated using conventional cost analysis and those using Should Cost could not be made. On the fourth contract, all contract work had been completed and the final contract price had been settled in accordance with the incentive provisions of the Fixed-Price-Incentive (FPI) type contract. However, the total price was negotiated and no separate agreement was made with the contractor regarding the sub-elements of cost. This total price settlement approach was supported by a sub-element cost breakdown of what the Government negotiator considered to be the individual sub-element cost settlement and could have been used to support the originally contemplated research approach. The one contract represented only one of four potential items to be included in the research sample. Therefore, it was decided not to perform future research at the sub-element level of cost analyses but to limit the analysis associated with testing the research hypothesis at the total cost level.

The preliminary investigation provided further insight into the data base, specifically with respect to the accounting for the effect of contract changes upon the

final contract cost. A contract cost change (modification) is a legal and binding change to the contract with an attendant increase or decrease in cost as the consideration for the action. More specifically, a contract modification means any written alteration in the specification, delivery point, rate of delivery, contract period, price, quantity, or other contract provisions of an existing contract, whether performed by unilateral action in accordance with a contract provision, or by mutual action of the parties to the contract. It includes bilateral actions such as supplemental agreements, unilateral actions such as change orders, administrative changes, notices of termination, and notices of the exercise of a contract option (21:1:15). Peck and Scherer have stated that in most market environments a pervasive optimistic bias in sellers' promises, and especially in price quotations, would have dire consequences--either widespread bankruptcy or the breakdown of traditional contract law. They further stated that in the nonmarket environment of advanced weapons acquisition, competitive optimism flourishes since the penalties for underestimation of costs are seldom severe (13:414). Almost every weapons systems acquisition is covered by some sort of cost reimbursable or cost redeterminable provision which assures a contractor of recovering his cost, oftentimes even if the costs turn out to be significantly higher than the contractor's

original estimates (13:416). This situation as highlighted by Peck and Scherer was observed during the preliminary investigation performed during this research effort. An example of this type situation is shown in Table 3.

Table 3
EXAMPLE OF EFFECT OF CONTRACT CHANGES ON
NEGOTIATED AND FINAL NEGOTIATED CONTRACT COST

| <u>Contractor #5</u> | |
|---------------------------------------------|-------------------|
| Initial Negotiated Contract Cost | \$112 Million |
| Add: Contract Changes (41 Contract Actions) | <u>31 Million</u> |
| Final Negotiated Contract Cost | \$143 Million |

Referring to the above table, the forty-one contract changes can be classified into three categories:

(1) configuration changes; (2) task changes, and (3) program changes. These categories of changes have been explained as follows (5:363):

Configuration changes alter the configuration of a system being built for delivery to the Government. They may change or delete an existing part, or add a new one. For example, a change that alters the structure of any part or component of a production aircraft is a configuration change. Configuration changes are authorized in Engineering Change Proposals and are frequently referred to as engineering changes.

A *task change* does not usually refer to changes in hardware. Task changes, for example, may restructure test programs or feasibility studies. Although task changes are not like engineering changes, in

practice proposed task changes are usually supported by Engineering Change Proposals. For this reason, task changes are also frequently referred to as engineering changes.

Program changes involve major--and usually very costly--revisions to quantities, technical performance specifications, delivery schedules, or rate of funding for a program.

Every negotiation for a change order occurs in a sole-source environment (5:376). In such a case, the contractor is in a strong position to negotiate, and if for example, the contractor had submitted an unrealistically low proposal (buy-in), he may try to recoup some of his losses by generating numerous contract changes. In addition, since contractor profits normally are negotiated as a percentage of cost, the contractor may be motivated to create additional cost producing tasks as a means for acquiring more profit (5:377). Based upon the Table 3 (page 29) observation and the above discussion, the researchers included the impact of contract change orders (revisions) on cost and profit as a variable to be tested by this research study.

In summary, the preliminary investigation was a worthwhile effort which facilitated the ease of performing the later research work and indicated that it was a feasible research approach to compare the final cost results of contracts negotiated using conventional cost analysis techniques to those negotiated using the Should Cost technique.

Universe

In research work, the entire set of elements to which the researcher wishes to generalize conclusions is referred to as the universe. The universe considered in this study consisted of approximately 7,000 contracts negotiated by ASD during the calendar year period 1971-1974. However, the universe contained a variety of types of contracts of which all but twenty-three were negotiated using conventional cost analysis techniques. Therefore, the universe had little or no bearing on the sample selection used in this research and is mentioned only to show the relative number of contracts negotiated using the Should Cost method.

Population of Interest

Population definition. This study deals with a finite population; that is, one with specific limits or boundaries. While the universe represents the entire set of elements of concern, a population is defined as the entire set of values which results from the measurement of some characteristics of all the elements of the universe. This measurement may take the form of quantitative variates or the presence or absence of some qualitative characteristic.

As previously mentioned, ASD conducted twenty-three Should Cost analyses during the time period under

study. The population considered in this research study consisted of these twenty-three Should Cost analyses.

Description. In performing the research work, the population of twenty-three Should Cost studies was stratified into two subgroups: one subgroup consisted of seventeen Fixed-Price-Incentive (FPI) contracts; the other subgroup included six Firm Fixed Price (FFP) contracts. FFP type contracts are not subject to a redetermination of costs after the contract work has been completed (21:3-104); therefore, those FFP contracts were excluded from the population of interest since the Government does not have access to the final cost data as a matter of routine cost evaluation. FPI type contracts are subject to redetermination of costs after the contract work has been completed. Under FPI type contracts, cost savings or overruns are shared by the buyer and seller in accordance with a predetermined profit-sharing formula. With most FPI contracts, the contractor is responsible for all costs in excess of the ceiling price, commonly referred to as the point-of-total assumption, or the point where the contract effectively reverts to a FFP arrangement.

The remaining seventeen contracts, negotiated using the Should Cost method, comprised the stratified population from which a convenience sample was taken for purposes of this research study.

Data Collection

To test the research hypothesis, two convenience samples, one consisting of conventional cost analysis and the other consisting of Should Cost contracts, were taken. The two samples were categorized for testing purposes as Group A (conventional cost analysis) and Group B (Should Cost).

Should Cost contracts. During the initial research, it was determined that, of the seventeen Should Cost contracts in the stratified population, final costs were available or could be accurately estimated for four contracts. These four contracts served as the sample of convenience of Should Cost contracts. A convenience sample is a sample that is obtained when practical considerations force the use of conveniently available data (final costs in this case).

Conventional cost analysis (non-Should Cost) contracts.

For purposes of comparing the Should Cost to non-Should Cost contracts, another convenience sample, of conventional cost analysis contracts, was taken. The sample consisted of four contracts; one each representing the previous fiscal year buy of the same product from the same contractor as each of the respective four Should Cost contracts. As an example, a Should Cost study was performed on the FY72 procurement from Contractor #3. Therefore, for

comparison to the FY72 buy, the FY 1971 procurement from Contractor #3, which was not negotiated under Should Cost guidelines, was selected for review.

The selection of the contracts representing previous year buys of the same product from the same contractor, as the convenience sample of non-Should Cost contracts, was made to facilitate the paired comparison of the cost outcomes between Should Cost and non-Should Cost contracts.

Performance results. The performance results; i.e., the contract cost outcomes associated with the various stages of contract activity, were collected for each of the contracts in the two samples. This cost information was obtained by examining results of individually documented Should Cost studies, data from actual contracts, and data from contract reports.

The results of the individual Should Cost studies are documented in Price Negotiation Memoranda (PNM) as no separate, formal Should Cost reports are issued (22: 7-1). Similarly, the results of conventionally negotiated contracts are included in the PNM. The PNM, which serves as the record of negotiations, and is completed after a contract is negotiated, contains data related to the contractor's originally proposed cost/price, the Government's negotiation objective, and the negotiated cost/price.

The cost information collected was classified into total costs for each of the five stages of contract activity. These stages of contract activity are listed and defined below.

Proposed: This contract activity stage represents the contractor proposal action taken in response to the Government's initial "Request for Proposal." The total cost value associated with this stage of contract activity represents the contractor's initial contract *cost* proposal in millions of dollars.

Negotiated: This contract activity stage represents the results of the negotiation action relative to establishing the contract cost (exclusive of profits or fee). The total cost value associated with this stage of contract activity represents the negotiated *cost* proposal in millions of dollars.

Revisions: This contract activity stage represents the contract revisions which were negotiated as a result of contract change activity (see Chapter 3, Preliminary Investigation, for further explanation of contract changes). The total cost value associated with this stage of contract activity represents the negotiated contract *cost* amount in millions of dollars for the several changes negotiated.

Revised Negotiated: This contract activity stage represents the results of the negotiation action relative to establishing the *revised* contract cost (exclusive of profit or fees). The total cost value associated with this stage of contract activity represents the total revised contract *cost* baseline in millions of dollars against which final completed costs are compared.

Completed: This contract activity stage represents the accumulation process of gathering all costs which have been incurred in the performance of the contract work. The total cost value associated with this stage of contract activity represents the final *actual contract costs* in millions of dollars.

The data pertaining to the total cost outcomes of each stage of contract activity for each contractor in

the two sample groups served as the basis for analysis and statistical testing which are discussed in Chapter 4.

The information presented on the next page summarizes the delimiting process which resulted in the obtaining of the cost data used in this research (Figure 1).

Summary List of Assumptions/
Limitations

Assumptions. The assumptions made in connection with this study follow:

1. That the population of Should Cost studies were conducted in accordance with AF Pamphlet 70-5, "Should Cost," which sets forth the Air Force concept of and approach to Should Cost as well as establishes detailed procedures which may be useful in conducting the Should Cost reviews (20:i). As the same criteria were applied to the conduct of these Should Cost studies, it was assumed that the sample of convenience is representative of the population of Should Cost contracts.

2. All contract work had not been completed on three of the four Should Cost contracts included in the sample of convenience. For those three contracts, final costs were estimated based on cost data and percentage of work completed (97 percent) obtained from Cost Performance Reports or Alternate Management Summary Reports. It

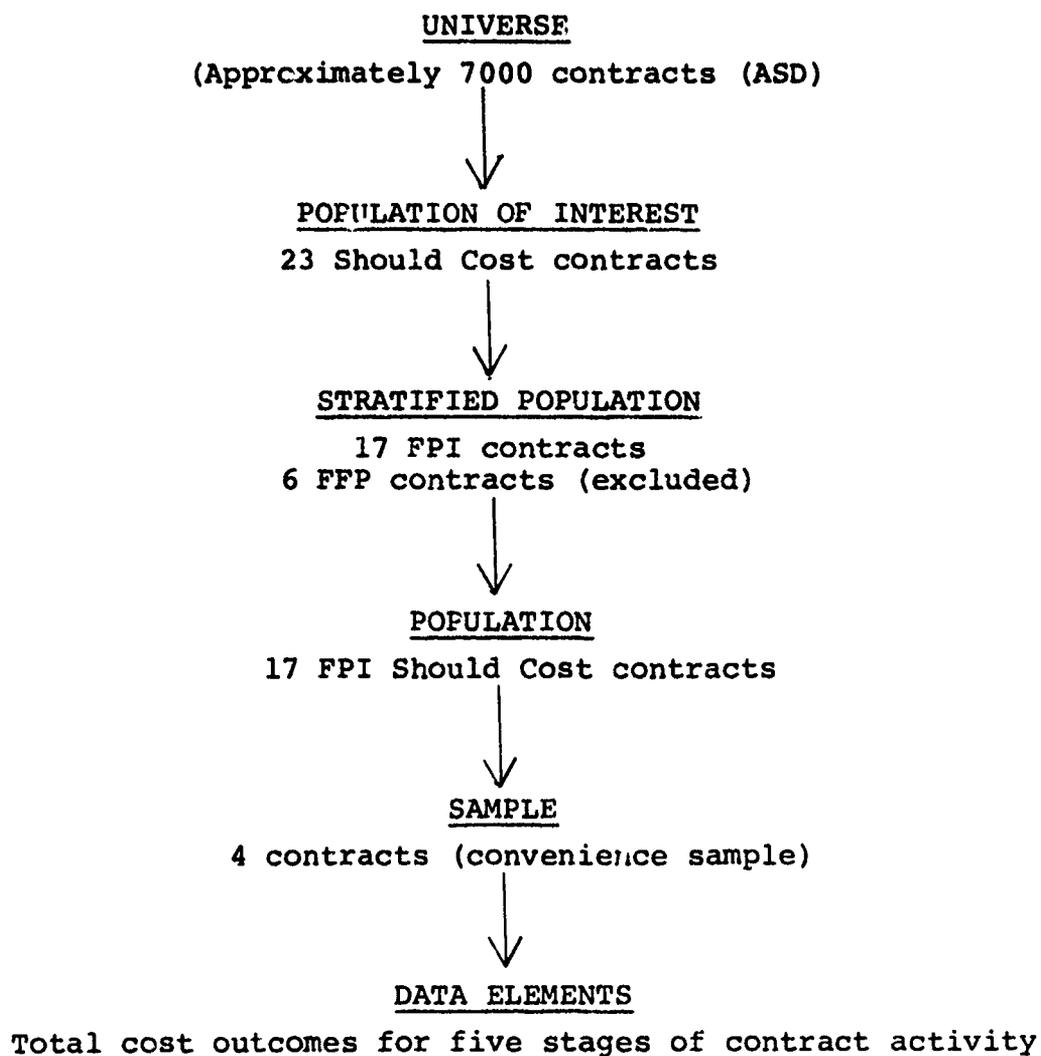


Figure 1

Summary of Delimiting Process

was assumed that both the percentage of work completed and the contract costs reported were accurate.

Limitations. The limitations of this study are as follows:

1. The study was not intended to allow for generalization of results to a larger population than that surveyed within the Aeronautical Systems Division.
2. The Should Cost studies conducted during the 1971-1972 time period placed less emphasis on the identification of long-term contractor management recommendations. Due to greater concern by both the Air Force and the General Accounting Office, the more recent (1973-1974) Should Cost studies placed greater emphasis on identification and implementation of long-term contractor management recommendations. However, these management type recommendations generally do not lend themselves to quantitative assessment due to their long-term nature; an inability for existing contractor accounting systems to isolate the applicable costs; and the absence of appropriate cost reporting systems.
3. The number of Should Cost contracts where the completed actual cost data were available was limited. Final costs were available, or could be accurately estimated, for four contracts from the population of seventeen Should Cost contracts.
4. The availability of the final cost data, as a practical consideration, forced the selection of the

four contracts as a sample of convenience in lieu of a randomly selected sample from the Should Cost contract population.

5. The study was concerned with the Air Force conception and application of the Should Cost technique vis-a-vis that of the Army, Navy, or General Accounting Office.

6. Table 4, Group A, Contractor #3 and Contractor #4 (shown in Chapter 4) include data that were adjusted by the researchers to reflect a proposed contract cost amount based upon a straight-line extrapolation of 3.9 percent upward from the negotiated amount of \$166.2 million.

Chapter 4

DATA ANALYSIS

General

The basic data used in this research was obtained from records and reports maintained by the Aeronautical Systems Division (ASD). A general description of the data and the time period from which the data was gathered are explained in the Population of Interest section of Chapter 3. Details of the data collection procedures will be explained below.

Data collection and conversion. As explained in Chapter 3, the two samples of convenience were taken and categorized as: Group A--Contracts Negotiated Using Conventional Cost Analysis; and Group B--Contracts Negotiated Using Should Cost. For each contract in these two sample groups, total cost data by stage of contract activity (proposed, negotiated, revisions, revised negotiated, and completed), were collected. Table 4 depicts these cost totals for the sample contracts. As shown in the table, the total cost for contractors #3 and #4 in Group A are the same. As stated above, two samples of convenience, each consisting of four contracts, were taken as a means for comparing the cost results of contracts negotiated using

Table 4
TOTAL COSTS PER CONTRACT ACTIVITY
STAGE OF SAMPLE CONTRACTS

| CONVENTIONAL COST ANALYSIS (GROUP A) (Total Costs \$ Millions) | | | | |
|-------------------------------------------------------------------|------------------|------------------|------------------|------------------|
| Stages of Contract Activity | Contractor #1 | Contractor #2 | Contractor #3 | Contractor #4 |
| Proposed | 17.7 | 2.7 | 199.7/172.9** | 199.7/172.9** |
| Negotiated | 15.7 | 2.6 | 192.0/166.2* | 192.0/166.2* |
| Revisions | 1.1 | 1.0 | 7.2 | 7.2 |
| Revised Negotiated | 16.8 | 3.6 | 173.4 | 173.4 |
| Completed | 21.3 | 4.9 | 167.5 | 167.5 |

| SHOULD COST (GROUP B) (Total Costs \$ Millions) | | | | |
|----------------------------------------------------|------------------|------------------|------------------|------------------|
| Stages of Contract Activity | Contractor #1 | Contractor #2 | Contractor #3 | Contractor #4 |
| Proposed | 5.2 | 2.0 | 338.9 | 227.9 |
| Negotiated | 4.9 | 1.8 | 266.2 | 182.1 |
| Revisions | -0- | .2 | 39.8 | 24.6 |
| Revised Negotiated | 4.9 | 2.0 | 306.0 | 206.7 |
| Completed | 4.9 | 2.0 | 259.5 | 176.3 |

*Quantity bought was reduced due to lack of funds thus resulting in a negotiated base amount of \$166.2 million versus \$192.0 million for a higher quantity.

**To facilitate computations, an estimate of (172.9) for the proposed amount for the reduced quantity was made based on a straight-line extrapolation of 3.9 percent upward from the negotiated amount of 166.2 of the reduced quantity.

Source: ASD Records and Reports.

conventional cost analysis (Group A) versus contracts negotiated using Should Cost (Group B). In order to make the paired comparisons between the two samples, by contractor, a baseline was established. In these cases, the baseline was the previous year or last contract negotiated using the conventional cost analysis technique with the contractor for the same product. Accordingly, the *coded* Contractor #3 and Contractor #4 cost data in Table 4 were from the same contract since there were two consecutive Should Cost studies performed on the contractor for two succeeding product buys. This data generally was not readily available from one location; therefore, several visits to various offices were required to obtain the data. The following represents the locations and source documentation from which the research data related to this study were obtained:

Location

Pricing Directorate, ASD

System Program Office, ASD
Program Control Office
Procuring Contracting Office

Contract Files Control Office, ASD

Procurement Operations/Reports Control Office,
ASD

Documentation

Price Negotiation Memoranda

Cost Performance Reports

Alternate Management Summary Reports
Procuring Contracting Officer Contract
Document Log

The cost data collected by contract activity stage was then converted into two data element forms suitable for hypothesis testing. The first form was the percent change (increase/decrease) of cost outcomes between activity stages. In this case, the percent changes from: (1) negotiated to proposed, (2) completed to proposed, and (3) completed to revised negotiated costs were computed. These percent changes were chosen for the hypothesis testing as they were considered by the researchers to best represent measures of the quantitative cost reduction accomplishments of the Should Cost efforts to date.

The other form was the ratio or percentage of the costs of contract revisions to: (1) the cost outcome of the proposed stage of contract activity, and (2) the cost outcome of the negotiated stage of contract activity. These percentages were chosen for the hypothesis testing because, as stated in the preliminary investigation in Chapter 3, the percentages reflect the effect contract changes (revisions) have upon the final contract cost outcome.

The cost data, having been converted into one of the two forms described above, was then used to make the necessary statistical analyses incidental to the hypothesis

testing. The information relating to the converted data for each contract in the sample groups is contained in Appendix B.

Problems in data collection. As previously mentioned, the primary objective of this research study was to quantify the comparison of contract cost outcomes on Should Cost negotiated contracts versus those negotiated using conventional cost analysis techniques. To accomplish that objective, it was essential to obtain not only the initially negotiated contract cost data but completed actual contract cost data as well. Here the researchers experienced two basic difficulties. First, there was a limited number of Should Cost contracts where the completed actual contract cost data were available. This difficulty, while a limitation for this research study, could be overcome through replication of this data and use of an expanded sample by future researchers. The next problem associated with data collection was that of identifying a single repository where the data could be located. Earlier in this chapter, four separate locations/offices were mentioned where the required data were found. During the research, each of those offices was visited to obtain the required data. Although each of the offices supplied valuable data to the overall effort, it was found that the System Program Office was often the location with the most usable repository of data.

Hypothesis Testing

It was determined by the researchers that hypothesis testing performed on three combinations of paired data elements from the sample groups would be appropriate in the testing of the basic research hypothesis. Using the calculated data previously described, the average differences between the two sample groups of the percent changes from: (1) Proposed to Negotiated, (2) Proposed to Completed, and (3) Revised Negotiated to Completed costs were compared and tested for statistical significance by construction of a confidence interval for Δ around each average difference. A description of the results of the testing of each data combination follows.

Combination 1--Proposed Cost to Negotiated Cost. For this test, the percentage changes of the Proposed to Negotiated costs for each of the four sample contracts negotiated using conventional cost analysis and negotiated using the Should Cost method were compared. Next, the difference between the percent change in each paired group (non-Should Cost versus Should Cost) was computed (see Table 5) and an average difference (\bar{D}) of 8.65 percent for the two groups was established. A standard deviation (S_D) of 10.7 percent was computed using the \bar{D} . A ninety-five percent confidence interval for Δ , around the \bar{D} , was calculated as follows:

Table 5
 PROPOSED COST TO NEGOTIATED COST (PERCENT CHANGE)

| CONTRACTOR | BEFORE (CONVENTIONAL) | AFTER (SHOULD COST) | DIFFERENCE (D) | (D- \bar{D}) | (D- \bar{D}) ² |
|------------|--------------------------|------------------------|-------------------|-----------------|------------------------------|
| #1 | -11.3 | - 5.8 | - 5.5 | -14.1 | 200.2 |
| #2 | - 3.7 | -10.0 | 6.3 | - 2.3 | 5.5 |
| #3 | - 3.9 | -21.5 | 17.6 | 8.9 | 80.1 |
| #4 | - 3.9 | -20.1 | 16.2 | 7.6 | 57.0 |

$$\bar{D} = \frac{34.6}{4}$$

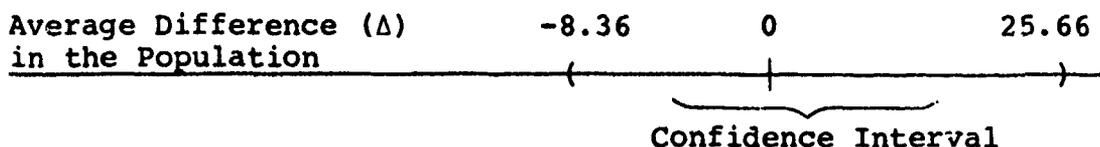
$$\bar{D} = 8.65$$

$$C.I. = D \pm t_{.025} \left(\frac{S_D}{\sqrt{n}} \right)$$

$$C.I. = 8.65 \pm 3.18 \left(\frac{10.7}{2} \right)$$

$$C.I. = -8.36 \text{ to } 25.66$$

Below is the graphical representation of the confidence interval.



Since the null hypothesis hypothesized that Δ equals zero and since the confidence interval for Δ encompasses zero, the null hypothesis cannot be rejected.

Combination 2--Proposed Cost to Completed Cost. In this test, the percent change of the Proposed to Completed costs for each of the four sample contracts negotiated using conventional cost analysis and negotiated using the Should Cost method were compared. The difference between the percent change in each paired group (non-Should Cost versus Should Cost) was then computed (see Table 6) and an average difference (\bar{D}) of 36.85 percent for the two groups was established. A standard deviation (S_D) of 29.9 percent was computed. A ninety-five percent confidence interval for Δ around the \bar{D} was calculated as follows:

Table 6
 PROPOSED COST TO COMPLETED COST (PERCENT CHANGE)

| CONTRACTOR | BEFORE (CONVENTIONAL) | AFTER (SHOULD COST) | DIFFERENCE (D) | (D- \bar{D}) | (D- \bar{D}) ² |
|------------|--------------------------|------------------------|-------------------|-----------------|------------------------------|
| #1 | 20.3 | - 5.8 | 26.1 | -10.8 | 115.6 |
| #2 | 81.5 | 0 | 81.5 | 44.6 | 1993.6 |
| #3 | -3.1 | -23.4 | 20.3 | -16.5 | 273.9 |
| #4 | -3.1 | -22.6 | 19.5 | -17.4 | 301.0 |

$$\bar{D} = \frac{147.2}{4}$$

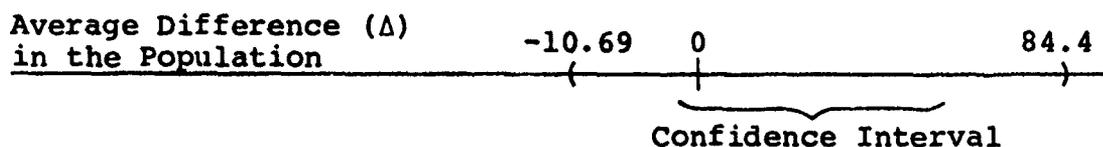
$$\bar{D} = 36.85$$

$$C.I. = \bar{D} \pm t_{.025} \left(\frac{S_D}{\sqrt{n}} \right)$$

$$C.I. = 36.85 \pm 3.18 \left(\frac{29.9}{2} \right)$$

$$C.I. = -10.69 \text{ to } 84.4$$

Below is the graphical representation of this confidence interval.



Since the null hypothesis hypothesized that Δ equals zero and since the confidence interval for Δ encompasses zero, the null hypothesis cannot be rejected.

Combination 3--Revised Negotiated Cost to Completed Cost.

For this test, the percent change of the Revised Negotiated to Completed costs for each of the sample contracts negotiated using conventional cost analysis and negotiated using the Should Cost method were compared. The difference between the percent change in each paired group (non-Should Cost versus Should Cost) was then computed (see Table 7) and an average difference (\bar{D}) of 21.85 percent for the two groups was established. A standard deviation (S_D) of 14.64 percent was computed. A ninety-five percent confidence interval for Δ around \bar{D} was calculated as follows:

Table 7
REVISED NEGOTIATED COST TO COMPLETED COST (PERCENT CHANGE)

| CONTRACTOR | BEFORE (CONVENTIONAL) | AFTER (SHOULD COST) | DIFFERENCE (D) | (D- \bar{D}) | (D- \bar{D}) ² |
|------------|--------------------------|------------------------|-------------------|-----------------|------------------------------|
| #1 | 26.8 | - 5.8 | 32.6 | 10.7 | 115.6 |
| #2 | 36.1 | 0 | 36.1 | 14.2 | 203.1 |
| #3 | -3.4 | -15.2 | 11.8 | 10.1 | 101.0 |
| #4 | -3.4 | -10.3 | 6.9 | 14.9 | 223.5 |

$$\bar{D} = \frac{87.4}{4}$$

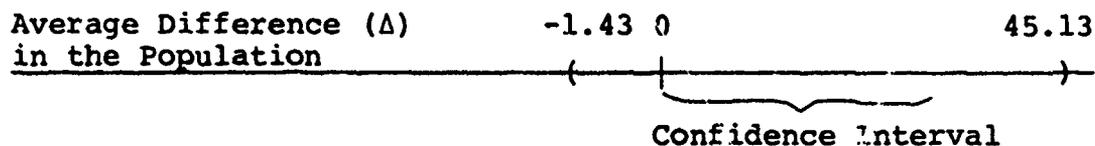
$$\bar{D} = 21.85$$

$$\text{C.I.} = \bar{D} \pm t_{.025} \left(\frac{S_D}{\sqrt{n}} \right)$$

$$\text{C.I.} = 21.85 \pm 3.18 \left(\frac{14.64}{2} \right)$$

$$\text{C.I.} = -1.43 \text{ to } 45.13$$

Below is the graphical representation of this confidence interval.



Since the null hypothesis hypothesized that Δ equals zero and since the confidence interval for Δ encompasses zero, the null hypothesis cannot be rejected.

In addition to the hypothesis testing using the three cost combinations cited above, statistical testing of the significance of the difference between the two paired sample groups (non-Should Cost versus Should Cost) of the costs of contract Revisions as a percentage of both the Proposed cost and the initial Negotiated cost was conducted. The results of the two additional tests are described below.

Costs of Revisions as percentage of Proposed cost. In this test, the values for the costs of Revisions as a percentage of the Proposed costs, for each of the four sample contracts negotiated using conventional cost

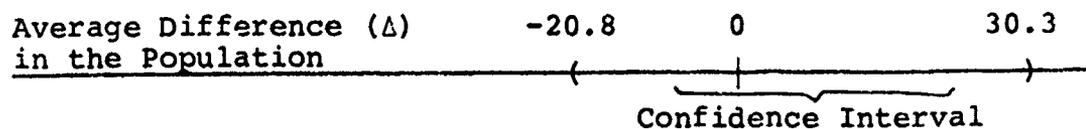
analysis and negotiated using the Should Cost method, were compared. Then, the difference between the percentages in each paired group (non-Should Cost versus Should Cost) was computed (see Table 8) and an average difference (\bar{D}) of 4.78 percent for the two groups was established. A standard deviation (S_D) of 16.08 percent was computed using the \bar{D} . A ninety-five percent confidence interval for Δ , around the \bar{D} , was calculated as follows:

$$C.I. = \bar{D} \pm t_{.025} \left(\frac{S_D}{\sqrt{n}} \right)$$

$$C.I. = 4.78 \pm 3.18 \left(\frac{16.08}{2} \right)$$

$$C.I. = -20.8 \text{ to } 30.3$$

The graph for this confidence interval is below.



Since the null hypothesis hypothesized that Δ equals zero and since the confidence interval for Δ includes zero, the null hypothesis cannot be rejected.

Costs of Revisions as percentage of Negotiated costs. For this test, the values for the costs of Revisions as a percentage of the Negotiated costs, for each of the four sample contracts negotiated using conventional cost analysis and

Table 8
COSTS OF REVISIONS AS PERCENTAGE OF PROPOSED COST

| CONTRACTOR | BEFORE (CONVENTIONAL) | AFTER (SHOULD COST) | DIFFERENCE (D) | (D- \bar{D}) | (D- \bar{D}) ² |
|------------|--------------------------|------------------------|-------------------|-----------------|------------------------------|
| #1 | 6.2 | 0 | 6.2 | 1.4 | 2.0 |
| #2 | 37.0 | 10.0 | 27.0 | 22.2 | 494 |
| #3 | 4.2 | 11.7 | -7.5 | 12.3 | 150.7 |
| #4 | 4.2 | 10.8 | -6.6 | 11.4 | 129.4 |

$$\bar{D} = \frac{19.1}{4}$$

$$\bar{D} = 4.78$$

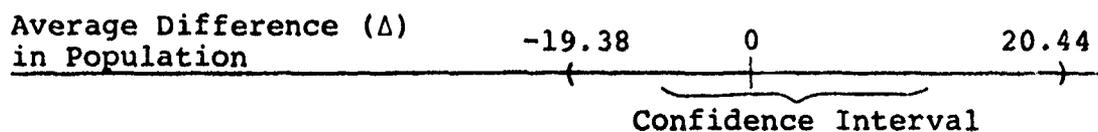
negotiated using the Should Cost method, were compared. The difference between the percentages in each paired group (non-Should Cost versus Should Cost) was computed (see Table 9) and an average difference (\bar{D}) of .53 percent for the two groups was established. A standard deviation (S_D) of 12.52 percent was computed using the \bar{D} . A ninety-five percent confidence interval for Δ , around \bar{D} , was calculated as follows:

$$\text{C.I.} = \bar{D} \pm t_{.025} \left(\frac{S_D}{\sqrt{n}} \right)$$

$$\text{C.I.} = .53 \pm 3.18 \left(\frac{12.52}{2} \right)$$

$$\text{C.I.} = -19.38 \text{ to } 20.44$$

The graphical representation for this confidence interval is depicted below.



As the null hypothesis hypothesized that Δ equals zero and since the confidence interval for Δ encompasses zero, the null hypothesis cannot be rejected.

Table 9

COSTS OF REVISIONS AS PERCENTAGE OF NEGOTIATED COST

| CONTRACTOR | BEFORE (CONVENTIONAL) | AFTER (SHOULD COST) | DIFFERENCE (D) | (D- \bar{D}) | (D- \bar{D}) ² |
|------------|--------------------------|------------------------|-------------------|-----------------|------------------------------|
| #1 | 7.1 | 0 | 7.1 | 6.6 | 43.2 |
| #2 | 26.0 | 11.0 | 14.9 | 14.4 | 206.5 |
| #3 | 4.3 | 15.0 | -10.7 | -11.2 | 126.1 |
| #4 | 4.3 | 13.5 | -9.2 | -9.7 | 94.7 |

$$\bar{D} = \frac{2.1}{4}$$

$$\bar{D} = .53$$

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the conclusions and associated recommendations developed as a result of this research study. In addition, recommendations for future research on the Should Cost subject are also presented.

Conclusions

Resulting from statistical analysis findings. The research hypothesis tested was:

There is a difference between the actual cost outcomes on contracts negotiated using Should Cost methods and the actual cost outcomes on those contracts negotiated using conventional cost analysis techniques.

The statistical test results did not support this hypothesis. As indicated previously in Chapter 3, statistical hypotheses were formulated to test the research hypothesis. Classical hypothesis testing methods were used and the research hypothesis or assumed condition became the "alternate" hypothesis for test purposes. The basic hypothesis that there is no difference between the cost outcomes of the two contract populations became the "null" hypothesis. For the research hypothesis (alternate hypothesis) to be supported, the statistical testing must result in rejection of the null hypothesis.

Five separate statistical tests were conducted to test the research hypothesis. The findings resulting from each of the statistical tests are described in Chapter 4. These findings as they relate to the conclusions concerning the research hypothesis are discussed below.

Test #1--Proposed cost to Negotiated cost. The finding resulting from this statistical test indicated that the null hypothesis cannot be rejected. Therefore, it can be concluded from the data there is no difference, at the .05 significance level, between the percent change from the Proposed to Negotiated costs for contracts negotiated using conventional cost analysis and for those negotiated using the Should Cost method.

Test #2--Proposed cost to Completed cost. The finding resulting from this statistical test indicated that the null hypothesis cannot be rejected. Therefore, it can be concluded from the data there is no difference, at the .05 significance level, between the percent change from the Proposed to Completed costs for contracts negotiated using conventional cost analysis and for those negotiated using the Should Cost method.

Test #3--Revised Negotiated cost to Completed cost. The finding resulting from this statistical test indicated that the null hypothesis cannot be rejected. Therefore,

it can be concluded from the data there is no difference, at the .05 significance level, between the percent change from the Revised Negotiated to Completed costs for contracts negotiated using conventional cost analysis and for those negotiated using the Should Cost method.

Test #4--Costs of Revision as Percentage of Proposed cost. The finding resulting from this statistical test indicated that the null hypothesis cannot be rejected. Therefore, it can be concluded from the data there is no difference, at the .05 significance level, between the percentage of the costs of Revisions to the Proposed costs for contracts negotiated using conventional cost analysis and for those negotiated using the Should Cost method.

Test #5--Costs of Revisions as Percentage of Negotiated cost. The findings resulting from this statistical test indicated that the null hypothesis cannot be rejected. Therefore, it can be concluded from the data there is no difference, at the .05 significance level, between the percentage of the costs of Revisions to the Negotiated costs for contracts negotiated using conventional cost analysis and for those negotiated using the Should Cost method.

The statistical tests measured the statistical significance of quantifiable cost outcomes at various stages of contract activity with the objective of supporting the research

hypothesis. However, the results of the testing did not support the research hypothesis. From the data used in this research study, it cannot be conclusively stated that there is a difference between the actual cost outcomes on contracts negotiated using Should Cost methods and the actual cost outcomes on those contracts negotiated using conventional cost analysis techniques. A summary of the results of the statistical hypothesis testing is contained in Table 10.

Resulting from corollary findings. As discussed earlier in connection with the preliminary investigation findings, contract changes (revisions) represent a significant cost and profit impact on most major procurements. During the research, it was found that significant contract price changes did develop on those contracts where Should Cost was applied, a situation not unlike that found on those contracts which were negotiated using conventional cost analysis techniques. A review of those changes did show that change activity increased contract target costs on three of the four contracts included in the Should Cost convenience sample. Most significant, however, as shown on Tables 3B and 4B (pages 81 and 82 respectively), contract changes were negotiated which added both cost and related profit to the contracts. Tables 3B and 4B do not reflect the added profit; however, the profit can be estimated by applying a 10.7 percent factor to the

Table 10

SUMMARY OF RESULTS OF STATISTICAL HYPOTHESIS TESTING

| Test | n | df | t | \bar{D} | S_D | Confidence Interval | Result |
|-----------------------------------------|---|----|-------|-----------|-------|---------------------|------------------------|
| Test #1 Proposed/Negotiated | 4 | 3 | 3.182 | 8.65 | 10.70 | +25.66 - 8.36 | Cannot Reject H_0 |
| Test #2 Proposed/Completed | 4 | 3 | 3.182 | 36.85 | 29.90 | +84.40 -10.69 | Cannot Reject H_0 |
| Test #3 Revised Negotiated/Completed | 4 | 3 | 3.182 | 21.85 | 14.64 | +45.13 - 1.43 | Cannot Reject H_0 |
| Test #4 Revision/Proposed | 4 | 3 | 3.182 | 4.78 | 16.08 | +30.34 -20.80 | Cannot Reject H_0 |
| Test #5 Revision/Negotiated | 4 | 3 | 3.182 | .53 | 12.52 | +20.44 -19.38 | Cannot Reject H_0 |

NOTE: n = number of observations per sample.

df = degrees of freedom.

t = t value for two-tailed test at .05 level of significance.

\bar{D} = average difference between like data elements in the two paired contract sample groups.

S_D = standard deviation.

"revisions" total cost amount. The 10.7 percent factor was obtained from the Price Negotiation Memoranda which documented the results of the respective contract negotiations. An analysis of the final cost outcome for two of these Group B contracts indicated that the contractor in both instances underran the initially negotiated target cost, hence a situation where the change activity cultivated a potential "windfall" profit situation. For example, the Group B contract as shown on Table 3B (page 81) provided for a 10.7 percent target profit factor and a 50 percent/50 percent under target share ratio. The "windfall" profit created by this situation (revisions) could approximate \$19.9 million dollars, calculated as follows:

$$\$39.8 \text{ million} \times 50\% = \$19.9 \text{ million} .$$

Summary. In summary, it is of importance to note that the sample of convenience included just four contracts out of a total of twenty-three contracts which had been negotiated using the Should Cost method. The question then, is that sample large enough to establish statistical significance? (Statistical significance simply means that enough data have been collected to establish that a difference does exist. It does not mean that the difference is necessarily important (23:188)). An intuitive answer in this case is that probably the sample is not large enough to conclusively indicate that Should Cost

does produce cost outcomes different than conventionally negotiated contract results.

The research performed during this study, while based on a limited sample, does give support to the belief that Should Cost may be producing results less than those originally anticipated from its use. At the same time, a corollary finding indicated that the use of the technique may give rise to greater or continued use of contract changes which could result in "windfall" profits notwithstanding the fact the original Should Cost study was effective. Accordingly, appropriate recommendations regarding these issues will be offered as a basis for further research in this subject area.

Recommendations

Based upon the findings and conclusions of the research, the following recommendations are made:

A. To discourage the use of contract changes as a potential strategy usable by firms who have negotiated tight contract cost targets as a result of Should Cost, it is recommended that: (1) the Government closely evaluate the need for the proposed change; and (2) consider the use of a "no fee or profit" policy below a certain dollar threshold for these added efforts.

B. It is recommended that the research approach taken by this study be used to undertake an expanded study of the results of Should Cost activity experienced

by the other Military Services as well as additional
Should Cost activity which will have been concluded by
the Air Force.

Chapter 6

FUTURE RESEARCH

As a result of the research work performed in this effort, certain postulations were made which were considered significant enough to warrant further mention in this thesis report. It is intended that these postulates be considered as a basis for further research which could be performed as a means for illuminating the deficiencies which Should Cost seeks to correct.

Evolutional Pattern and Environment of Should Cost

Numerous articles and research works have been published generally dealing with the "how to" and "by whom" mechanics for conducting Should Cost reviews. As previously mentioned, this research study sought to compare the effectiveness of final cost outcomes for those contracts negotiated using Should Cost to the final cost outcomes for those contracts negotiated using conventional cost analysis. While the results of this research did indicate that it can be concluded that there is no difference, at the .05 significance level, between those actual cost outcomes for Should Cost versus non-Should Cost negotiated contracts, it remains that a more in-depth analysis of Should Cost over the long-term is in order.

The degree of analysis developed in this chapter will be limited to a summary treatment of a significant issue as a means for setting the stage for future research; namely, organizational behavioral implications of the Should Cost technique. Should Cost as applied by the DOD has taken an accounting and industrial engineering approach toward a complex problem. Inherent in the acquisition of major weapon systems is the constant interaction of multi-disciplined Government and contractor organizations such as the Defense Contract Administration Services (DCAS), Defense Contract Audit Agency (DCAA), and major commodity buying activities such as ASD of the Air Force Systems Command (AFSC). Within that interactive system are processes which require or produce cost estimates, over time, related to the acquisition at hand. Those activities are conducted by the Government and its contractors in an atmosphere conducive to contract negotiations. However, Should Cost interjects itself at a finite point in time with the seemingly insurmountable objective of predicting what a system, subsystem, or component ought to cost, given reasonably attainable efficient standards of operation. This quantitatively-oriented view of the problem seems to discount the organizational behavior relationships essential for achieving the longer range objectives of efficient operation. The significance of the above statement is that Should Cost may be an ad hoc

answer to a deeply rooted organizational behavior problem such as a roles and missions question between the participating organizations which could result in duplications of effort. The ad hoc nature of the approach may sub-optimize to achieve near term economic relief in the form of lowered contract price objectives. However, the reality of this ad hoc approach is that it manifests itself as a change to an organizational structure without allowing for assessment of its impact on the existing organizational structure represented by the Defense and industry establishments.

The DOD has organized functionally to conduct its acquisition activities. This organizational structure has produced characteristics expected of such an approach: specialization, centralization, systemization, and process configuration. The following discussion is offered as a means to better relate these characteristics to the DOD organization with respect to the acquisition process. DOD organizations such as DCAS, DCAA, and major commodity buying activities such as ASD are representative of such specialized organizations. Basic to such an organizational structure is the reduction of centralized authority with the offsetting phenomena of increased authority configuration or chain of command. The activities of the various organizations are so diverse, yet virtually essential to the overall acquisition process, that they must be

conducted in a systematized fashion, hence the need for regulations, rules and other codes of operation. The idea of process configuration is synonymous with integration or, in other words, once work is broken out, it must be pulled together to accomplish the overall acquisition objective. But back to the basic question: Where does Should Cost fit into this structure? At the risk of oversimplification, it can be said that Should Cost is a means for correcting problems caused by inadequacies associated with a functionally organized activity. While the label "Should Cost" serves the valuable purpose of broadcasting the importance of improving efficiency and reducing cost, it at the same time diverts attention from the vital issue of organizational relationships basic to the survival of any institution. This can best be characterized by William G. Scott's comment (14:665):

Few segments of society have engaged in organizing more intensively than business. The reason is clear. Business depends on what organization offers. Business needs a system of relationships among functions; it needs stability, continuity, and predictability in its internal activities and external contacts. Business also appears to need harmonious relationships among the people and processes which make it up. Put another way, a business organization has to be free, relatively, from destructive tendencies which may be caused by divergent interests.

The above cursory treatment of a complex issue which is beyond the scope of this thesis, leaves room for greater explanations and more intense investigation which could be undertaken as a separate research effort. However,

the significant point that can be made was made by Scott, and that essentially is that business needs a system of harmonious relationships among functions, along with stability, continuity and predictability. Should Cost as an ad hoc technique violates at least the stability and continuity features of the business relationship. However, the results of this "violation" could be either favorable or unfavorable. In the case of the favorable outcome, it can be said that Should Cost provides the motivation to purge organizational inertia from both the contractor organization and Government contract administration organization as well. In the case of the unfavorable outcome, the Should Cost approach can disrupt the stability and continuity inherent in an effective contractor and Government contract administration activity. Therefore, the real question is: Will the DOD-Industry relationship thrive or suffer under the superimposition of this ad hoc technique over a business-oriented institution?

Production--An Integral Part
of the Should Cost Technique

The economic environment associated with the type of acquisition on which Should Cost is used is one where the Government is a captive customer, subject to the constraints common to a situation where there is no competition (10:16-24). Costs are functions of the production

processes inherent in the activities performed by any manufacturing organization. The key underlying these activities is the production process which inevitably is translated into a common denominator, namely contract cost or price. Gary E. Hagen (7:1-15) stated that the term "Production" is subject to a variety of definitions. As an example, the Air Force Systems Command has said that production is difficult to define so that it means the same to ACOs, PCOs, program directors, contractors, and Air Force production specialists (18:9). This result is not unlike that experienced by practitioners and recipients of the Should Cost technique. Therefore, to set the stage for further discussion of Should Cost from a production viewpoint, the following definition of production is offered: Production includes all processes and procedures designed to transform a set of input elements into a specific output element. Its major functions include design or producibility, production planning, production control, production demonstration and testing, manufacturing method development, fabrication, assembly, installation, checkout, scheduling, and production program surveillance (19:1-5). This definition is comprehensive and covers many of the underlying activities embodied in Should Cost. Mr. Hagen's discussion of production management as it applies during system acquisition provided insight into the basic underlying production foundation which Should

Cost seeks to treat in an ad hoc fashion (7). He raised the issue that the constant change in manufacturing technology over the years has outstripped the knowledge and skill levels of many of the Air Force personnel assigned to the production function (19:3). This is a void which Should Cost has sought to fill.

The 1960s was a period fraught with cost growth and fixed price type contracting. The assumption during that era essentially was that fixed price incentive contracting provided sufficient profit motivation and risk assumption by contractors to promote efficient production of defense material items. The resultant contracting activity led to a change in the Government role from one of heavy involvement to one of surveillance. The outcome of that era as now being experienced during the 1970s is greater use of cost type contracting, hence greater Government engagement with contractors in the management of their mutual objectives.

In summary, production can be construed to be the central theme of Should Cost. However, Should Cost usually occurs at a finite point in time and on an ad hoc basis during the production phase of acquisition. Production planning and operations, on the other hand, are constant processes that span the breadth of the acquisition cycle. This point is supported by the Air Force Systems Command statement that the success of the production phase

is dependent in large measure on the extent and quality of the planning and assessment of work accomplished during the development cycle of the acquisition process (18:16).

It is essential to again point out that production processes and planning are the key functions which need to be considered by the Government and its contractors on a continuing day-to-day basis if the mutual interests of both parties and the nation are to be preserved.

Summary of and Recommendation
for Future Research

Should cost has proved to be a valuable method for calling attention, from both within the Government and within industry, to the need for greater contractor plant-wide cost effectiveness (11:19). However, in all probability, as evidenced by the Chapter 4 findings, contractors may have adjusted to Should Cost and the increased adversary atmosphere created by its application. To incur lasting effect from Should Cost's initial impact, it seems that both Government and industry together must mutually promote production/industrial engineering related efficiencies which are basic to the Should Cost technique. This undertaking will not be something which can be mandated; rather, it must be initiated in a cooperative vein with participation from all concerned organizations. These organizations include the Service buying activities, Defense Contract Administration Services (DCAS), Air Force

Plant Representative Offices (AFPRO), Defense Contract Audit Agency (DCAA), and contractors.

It is believed that a program of this nature could be initiated at the Office of Secretary of Defense (OSD) level in the form of a "Management by Objectives" approach whereby the Office of the Secretary of Defense, the Services, and the separate Defense Agencies jointly identify their common goals, define each organization's major areas of responsibility in terms of the results expected of it, and use these measures as guides for directing the individual organization's day-to-day efforts towards accomplishing the objectives sought by Should Cost on an ad hoc basis (6:245-251; 12:13).

Based upon the above discussion, it is recommended that research be conducted with respect to the impinging organizational behavioral impact generated as a result of using the ad hoc Should Cost technique.

APPENDICES

1 July 1974

F131

DEPARTMENT OF DEFENSE FORMS
F-200.633 DD Form 633: Contract Pricing Proposal

| DEPARTMENT OF DEFENSE CONTRACT PRICING PROPOSAL | | Form Approved Budget Bureau No. 22-8100 | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------------------------|--------------------------------|
| This form is for use when submission of cost or pricing data (see ASPR 3.007 2) is required | | FORM NO. | NO. OF PAGES |
| NAME OF OFFEROR | | SUPPLIES AND/OR SERVICES TO BE FURNISHED | |
| HOME OFFICE ADDRESS (Include ZIP Code) | | QUANTITY | TOTAL AMOUNT OF PROPOSAL \$ |
| DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED | | GOVERNMENT SOLICITATION NO. | |
| COST ELEMENTS | PROPOSED CONTRACT ESTIMATE | | |
| | TOTAL COST ¹ | UNIT COST ² | DIFFERENCE ³ |
| 1. DIRECT MATERIAL | | | |
| A. PURCHASED PARTS ⁴ | | | |
| B. SUBCONTRACTED ITEMS ⁵ | | | |
| (1) RAW MATERIAL ⁶ | | | |
| (2) STANDARD COMMERCIAL ITEMS ⁶ | | | |
| (3) INTERDISCIPLINARY TRANSFERS for other than cost ⁶ | | | |
| 2. MATERIAL OVERHEAD ⁷ | | | |
| 3. INTERDISCIPLINARY TRANSFERS AT COST ⁸ | | | |
| 4. DIRECT ENGINEERING LABOR ⁹ | | | |
| 5. ENGINEERING OVERHEAD ⁹ | | | |
| 6. DIRECT MANUFACTURING LABOR ¹⁰ | | | |
| 7. MANUFACTURING OVERHEAD ¹⁰ | | | |
| 8. OTHER COSTS ¹¹ | | | |
| 9. SUBTOTALS | | | |
| 10. GENERAL AND ADMINISTRATIVE EXPENSES ¹² | | | |
| 11. ROYALTIES ¹³ | | | |
| 12. FEDERAL EXCISE TAX ¹⁴ | | | |
| 13. SUBTOTALS | | | |
| 14. PROFIT OR FEE | | | |
| 15. TOTAL PRICE (Amount) | | | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO IF YES, IDENTIFY BELOW. HAVE THE DEPARTMENT OF DEFENSE, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, OR THE ATOMIC ENERGY COMMISSION PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT DURING THE PAST TWELVE MONTHS? | | | |
| NAME AND ADDRESS OF REVIEWING OFFICE (Include ZIP Code) | | TELEPHONE NUMBER | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO IF YES, IDENTIFY ON A SEPARATE PAGE. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT? | | | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO IF YES, IDENTIFY ON A SEPARATE PAGE. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? | | | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO IF YES, IDENTIFY: <input type="checkbox"/> ADVANCE PAYMENTS <input type="checkbox"/> DEFERRED PAYMENTS OR <input type="checkbox"/> GUARANTEE LOANS. HAVE YOU BEEN AWARDED ANY CONTRACTS OR SUBCONTRACTS FOR SIMILAR WORK WITHIN THE PAST THREE YEARS? | | | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO IF YES, SHOW CUSTOMER(S) AND CONTRACT NUMBER(S) BELOW OR ON A SEPARATE PAGE. | | | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO IF NO, EXPLAIN ON A SEPARATE PAGE. DOES THIS COST NUMBER CONFORM WITH THE COST PRINCIPLES SET FORTH IN ASPR SECTION 24 (300 PART 101)? | | | |
| This proposal is submitted for use in connection with and in response to _____ _____ and reflects our best estimates as of this date. | | | |
| IN ACCORDANCE WITH THE INSTRUCTIONS TO OFFERORS AND THE FOOTNOTES WHICH FOLLOW *ENCLOSE APP. ETC. | | | |
| TYPED NAME AND TITLE | | SIGNATURE | |
| NAME OF FIRM | | DATE OF SUBMISSION | |

DD FORM 633

PREVIOUS EDITIONS ARE OBSOLETE

F-200.633

ARMED SERVICES PROCUREMENT REGULATION

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APPENDIX B

CONVERTED CONTRACT COST DATA USED IN HYPOTHESIS TESTING

As defined in Chapter 4, the cost data collected by contract activity stage for each sample contract was converted into one of two data element forms suitable for hypothesis testing. The two forms were: (1) percent change (increase/decrease) of cost outcomes between contract activity stages and (2) ratio of percentage of the costs of contract revisions to proposed costs and to negotiated costs. The computations performed to convert the cost data into testing form are described below.

Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages

(1) Negotiated to Proposed: The proposed cost was used as the baseline in this computation. The proposed cost total was divided into the difference (increase/decrease) between the proposed cost and the negotiated cost. The resulting decimal was then multiplied by 100 to convert the decimal to a percent.

(2) Completed to Proposed: The proposed cost was used as the baseline in this computation. The proposed

Preceding page blank

cost total was divided into the difference (increase/decrease) between the proposed cost and the completed cost. The resulting decimal was then multiplied by 100 to convert the decimal to a percent.

(3) Completed to Revised Negotiated: The revised negotiated cost was used as the baseline in this computation. The revised negotiated cost total was divided into the difference (increase/decrease) between the revised negotiated cost and the completed cost. The resulting decimal was multiplied by 100 to convert the decimal to a percent.

Ratio or Percent of the Costs of
Contract Revisions to Proposed and
to Negotiated Costs

(1) Proposed: In this computation, a ratio was formed by dividing the proposed cost total into the total cost of the contract revisions. The resulting decimal was multiplied by 100 to convert the decimal to a percent.

(2) Negotiated: In this computation, a ratio was formed by dividing the negotiated cost total into the total cost of the contract revisions. The resulting decimal was multiplied by 100 to convert the decimal to a percent.

The converted cost data computed for each of the sample contracts and used in the statistical hypothesis testing is shown in Tables 1B through 4B.

Table 1B

CONVERTED CONTRACT COST DATA USED IN HYPOTHESIS TESTING--CONTRACTOR #1

| CONVENTIONAL COST ANALYSIS (GROUP A) | | | | | | | | | |
|--------------------------------------|--------------------------|--------------------------------------------------------------------------------------|--------------------|--------------------|------------|-------------------|------------|---------------------|------------|
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | Completed/Proposed | | Completed/Revised | | Negotiated/Proposed | |
| | | Negotiated/Proposed | Completed/Proposed | Revised | Negotiated | Proposed | Negotiated | Proposed | Negotiated |
| PROPOSED | 17.7 | | | | | | | | |
| NEGOTIATED | 15.7 | -11.3 | | | | | | | |
| REVISIONS | 1.1 | | | | | | | 6.2 | 7.1 |
| REVISED | | | | | | | | | |
| NEGOTIATED | 16.8 | | | | | | | | |
| COMPLETED | 21.3 | | 20.3 | | | | | | 26.8 |
| SHOULD COST (GROUP B) | | | | | | | | | |
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | Completed/Proposed | | Completed/Revised | | Negotiated/Proposed | |
| | | Negotiated/Proposed | Completed/Proposed | Revised | Negotiated | Proposed | Negotiated | Proposed | Negotiated |
| PROPOSED | 5.2 | | | | | | | | |
| NEGOTIATED | 4.9 | - 5.8 | | | | | | | |
| REVISIONS | -0- | | | | | | | -0- | -0- |
| REVISED | | | | | | | | | |
| NEGOTIATED | 4.9 | | | | | | | | |
| COMPLETED | 4.9 | | -5.8 | | | | | | -5.8 |

Table 2B

CONVERTED CONTRACT COST DATA USED IN HYPOTHESIS TESTING--CONTRACTOR #2

| CONVENTIONAL COST ANALYSIS (GROUP A) | | | | | | | | | |
|--------------------------------------|--------------------------|--------------------------------------------------------------------------------------|--------------------|------------------------------|-----------------------------------------------------------------------------------|-----------|------------|------|------|
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | | Ratio (Percentage) of the Costs of Contract Revisions to: Contract Activity Stage | | | | |
| | | Negotiated/Proposed | Completed/Proposed | Completed/Revised Negotiated | Proposed | Completed | Negotiated | | |
| PROPOSED . . . | 2.7 | | | | | | | | |
| NEGOTIATED . . . | 2.6 | -3.7 | | | | | | | |
| REVISIONS . . . | 1.0 | | | | | | | | |
| REVISED | | | | | | | | | |
| NEGOTIATED . . . | 3.6 | | | | | | | | |
| COMPLETED . . . | 4.9 | | 81.5 | | | | | 37.0 | 26.0 |
| | | | | | | | | | |
| SHOULD COST (GROUP B) | | | | | | | | | |
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | | Ratio (Percentage) of the Costs of Contract Revisions to: Contract Activity Stage | | | | |
| | | Negotiated/Proposed | Completed/Proposed | Completed/Revised Negotiated | Proposed | Completed | Negotiated | | |
| PROPOSED . . . | 2.0 | | | | | | | | |
| NEGOTIATED . . . | 1.8 | -10.0 | | | | | | | |
| REVISIONS . . . | .2 | | | | | | | | |
| REVISED | | | | | | | | | |
| NEGOTIATED . . . | 2.0 | | | | | | | | |
| COMPLETED . . . | 2.0 | | -0- | | | | | 10.0 | 11.1 |

Table 3B

CONVERTED CONTRACT COST DATA USED IN HYPOTHESIS TESTING--CONTRACTOR #3

| CONVENTIONAL COST ANALYSIS (GROUP A) | | | | | | | | | |
|--------------------------------------|--------------------------|--------------------------------------------------------------------------------------|--------------------|------------------------------|-----------------------------------------------------------------------------------|----------|------------|----------|------------|
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | | Ratio (Percentage) of the Costs of Contract Revisions to: Contract Activity Stage | | | Proposed | Negotiated |
| | | Negotiated/Proposed | Completed/Proposed | Completed/Revised Negotiated | Completed/Proposed | Proposed | Negotiated | | |
| PROPOSED | 172.9 | | | | | | | | |
| NEGOTIATED | 166.2 | -3.9 | | | | | | | |
| REVISIONS | 7.2 | | | | | | 4.2 | | 4.3 |
| REVISED | | | | | | | | | |
| NEGOTIATED | 173.4 | | | | | | | | |
| COMPLETED | 167.5 | | -3.1 | | | | | | -3.4 |
| SHOULD COST (GROUP B) | | | | | | | | | |
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | | Ratio (Percentage) of the Costs of Contract Revisions to: Contract Activity Stage | | | Proposed | Negotiated |
| | | Negotiated/Proposed | Completed/Proposed | Completed/Revised Negotiated | Completed/Proposed | Proposed | Negotiated | | |
| PROPOSED | 338.9 | | | | | | | | |
| NEGOTIATED | 266.2 | -21.5 | | | | | | | |
| REVISIONS | 39.8 | | | | | | 11.7 | | 15.0 |
| REVISED | | | | | | | | | |
| NEGOTIATED | 306.0 | | | | | | | | |
| COMPLETED | 259.5 | | -23.4 | | | | | | -15.2 |

Table 4B

CONVERTED CONTRACT COST DATA USED IN HYPOTHESIS TESTING--CONTRACTOR #4

| CONVENTIONAL COST ANALYSIS (GROUP A) | | | | | | |
|--------------------------------------|--------------------------|-----------------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------------------|------------|------------|
| Stages of Contract Activity | Total Cost (\$ Millions) | Percentage Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | Ratio (Percentage) of the Costs of Contract Revisions to: Contract Activity Stage | | Negotiated |
| | | Negotiated/Proposed | Completed/Revised Negotiated | Proposed | Negotiated | |
| PROPOSED | 172.9 | | | | | |
| NEGOTIATED | 166.2 | -3.9 | | 4.2 | | 4.3 |
| REVISIONS | 7.2 | | | | | |
| REVISED | | | | | | |
| NEGOTIATED | 173.4 | | | | | |
| COMPLETED | 167.5 | -3.1 | -3.4 | | | |
| SHOULD COST (GROUP B) | | | | | | |
| Stages of Contract Activity | Total Cost (\$ Millions) | Percent Change (Increase/Decrease) of Cost Outcomes Between Contract Activity Stages | | Ratio (Percentage) of the Costs of Contract Revisions to: Contract Activity Stage | | Negotiated |
| | | Negotiated/Proposed | Completed/Revised Negotiated | Proposed | Negotiated | |
| PROPOSED | 227.9 | | | | | |
| NEGOTIATED | 182.1 | -20.1 | | 10.8 | | 13.5 |
| REVISIONS | 24.6 | | | | | |
| REVISED | | | | | | |
| NEGOTIATED | 206.7 | | | | | |
| COMPLETED | 176.3 | -22.6 | -10.3 | | | |

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