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THE IMPACT OF THE PACKARD COMMISSION'S RECOMMENDATIONS ON REDUCING COST OVERRUNS IN MAJOR DEFENSE ACQUISITION PROGRAMS

THESIS

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THESIS

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Dave Searle

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Abstract

This thesis examines the impact that recommendations made by the President's Blue Ribbon Commission on Defense Management, informally known as the Packard Commission, had on reducing cost overruns in major DoD acquisition programs. Cost overruns are a recurring problem in the DoD, and the study of possible effects resulting from the implementation of acquisition reform efforts such as the Packard Commission study could alter this trend. In this era of acquisition reform and downsizing it's important that policy makers understand the effects past and current policies have had and are having on reducing the ever present problem of cost overruns. Conclusions drawn in this thesis may guide and direct DoD policy makers in drafting future regulations and policies.

This study examined 269 contracts completed between January 1, 1988 and December 31, 1995. It was found that cost performance for contracts completed after the recommendations went into effect was poorer than cost performance prior to the change. It was also found that a more significant difference occurred between contracts in development phases than those in production phases. In fact, percentage cost overruns for development contracts nearly tripled after the policy went into effect. Possible explanations and implications of this discovery are provided.

THE IMPACT OF THE PACKARD COMMISSION'S

RECOMMENDATIONS ON REDUCING COST OVERRUNS

IN MAJOR DEFENSE ACQUISITION PROGRAMS

I. Introduction

General Issue

The phenomenon of cost overruns in Department of Defense acquisition programs has been a problem for decades. In fact, regulations to control defense procurements extend as far back as the 1940's. However, these policies have accomplished little in controlling or reducing the problem. A 1993 Rand Corporation study discussed the extent of cost growth in the DoD and indicated that cost growth has fluctuated around 20 percent since the mid 1960's and that little improvement has occurred over time (Drezner and others, 1993:2). Other research indicates that the average cost overrun on DoD acquisition contracts is approximately 40 percent (Gansler, 1989:4). However one measures the unplanned cost increases (growth or overruns to be explained later in this thesis) is academic; the magnitude of the problem persists and is readily seen as 20 to 40 percent can represent a notable loss. In the 1980's, when public pressure on controlling defense spending was at its peak, critics estimated that in one year alone sloppiness, duplication, and fraud could add up to $23 billion which was about one third of total weapon procurement expenditures at that time (Griffiths, 1985:144). While procurement expenditures in the 1990's are less than half of the 1980's levels, the magnitude of DoD procurement activities remains significant, and over the last two decades it seems one is constantly hearing through the media that some defense program will cost taxpayers millions of dollars more than was budgeted.

President Reagan established the Packard Commission in 1986 in an effort to combat the still pervasive inefficiencies in the DoD's procurement system and to stimulate procurement reform. The group was officially called the President's Blue Ribbon Commission on Defense Management but was informally named the Packard Commission after its chairman, industrialist and former Deputy Secretary of Defense David Packard. They examined DoD management in general but concentrated particularly on the acquisition process. The Commission concluded that the primary problems with the acquisition process were the same inefficiencies of the 60's and 70's, namely cost growth, schedule delays, and performance shortfalls. Furthermore, they believed these inefficiencies were actually the problems and not just symptoms. In response the Commission issued a number of recommendations to alleviate these problems.

Background

Unplanned cost increases in the DoD's weapon system procurements can escalate to staggering amounts and can impact not only the operational users but the people of this country as well. Furthermore, cost growth can affect our national security. "For a long period of time, the government has been trying to reduce cost growth and increase visibility over defense acquisition programs" (AFSCP 173-4, 1989:5). In fact, over the last 25 years the DoD has implemented over 20 significant regulatory and administrative initiatives that were intended to improve cost performance in weapon system development (Drezner and others, 1993:28-29). Unfortunately, cost growth, perceived as an inefficiency in the procurement process, continued throughout the 1970's and 1980's. What was thought to have been controlled in the 1970's (cost growth) resurfaced as a pressing problem in the 1980's. In fact, cost growth in the 1980's seemed to be increasing (Singer, 1983:2; Drezner and others, 1993:30). It appears that none of the regulatory and administrative initiatives implemented in the 60's, 70's, or early 80's were successful in reducing cost growth in major defense acquisition contracts.

Statement of the Problem

The presence of cost overruns is a recurring problem in the DoD, and the study of possible effects resulting from the implementation of acquisition reform efforts such as the Packard Commission study could alter this trend. In this era of acquisition reform and downsizing it is important that policy makers understand the effects past and current policies have had and are having on the ever present problem of cost overruns. The overall goal of this research effort is to provide the DoD with an evaluation of a top level acquisition policy. This evaluation could then serve as a guide for policy makers by offering a critical evaluation of the current path of acquisition policy—specifically whether or not the DoD is heading in the "right" direction with regards to it's acquisition policies. Furthermore, this evaluation may reveal whether or not DoD acquisition policies are targeting the actual problems.

Answers to issues such as these would yield tremendous insight as to the appropriateness of current policies and the potential effectiveness of future policies. Conclusions drawn in this thesis may guide and direct DoD policy makers in the drafting of future regulations and policies.

The specific objective of this research is to test the effectiveness of the Packard Commission's recommendations on reducing cost overruns in Department of Defense acquisition programs. The research questions to be answered and the specific hypothesis to be tested are as follows:

1. Is the mean final overrun percentage (FO%) for contracts completed before Dec.31, 1991 different than the mean percentage afterwards? This will be determined by testing the following null hypothesis:

H1: Given a sample of completed contracts, the final overrun percentage for contracts completed after Dec. 31, 1991 is the same as the percent overrun of contracts completed before that date.

2. Does the mean FO% for contracts completed before and after Dec.31, 1991 differ between program phase? This will be determined by testing the following null hypotheses:

H2: Given a sample of completed development contracts, the final overrun percentage for contracts completed after Dec. 31, 1991 is the same as the percent overrun of contracts completed before that date.

H3: Given a sample of completed production contracts, the final overrun percentage for contracts completed after Dec. 31, is the same as the percent overrun of contracts completed before that date.

Currently there appear to be two schools of thought on the proper measurement of unplanned cost increases: cost growth and cost overruns. Several studies have used the terms interchangeably, but they are in fact referring to different measurements. While recognizing the contributions made by both measurements, this thesis distinguishes between the two and builds upon the cost overrun model as the measuring tool throughout this study. Also, this thesis measures percentage overruns rather than gross overruns as the unadjusted measure fails to consider contract size (in terms of dollar value) and inflation. By converting the unadjusted final overrun figure to a final overrun percentage one can adjust the figure for size and inflation thus providing a relative measure of cost performance.

Scope of the Study

The principal statistical analysis used in this study tests for differences in the population means of percentage overruns of contracts completed before and after the policy changes implemented from the Commission's recommendations. The procedure used to measure and compare the distributions of data will be discussed in Chapter 3. Using the sample mean as an estimator of the population mean allows for inferences to be made about the differences between population parameters.

The method applied in this study relies on cost performance data contained in the Defense Acquisition Executive Summary (DAES) database. This database contains cost performance data on completed contracts extending back as far as 1977 from every branch of the service. The database used in this study contains cost information from 378 programs encompassing 1,843 individual contracts. Because of its broad and extensive coverage the database can provide program and researchers with a valuable management tool highlighting "both potential and actual program problems to the Under Secretary of Defense (Acquisition and Technology) before they become significant" (DODI

5000.2, 1996:Part 6). The DAES database available for this study contains cost performance data from 1977 through 1995.

Organization of the Study

This thesis is organized in the traditional format. The following chapter introduces supportive information and related studies in order to build a foundation upon which the remainder of the thesis rests. That chapter will also answer the following investigative questions:

- What is the significance of cost overruns to the Department of Defense?
- What factors are believed to cause cost overruns in the Department of Defense?
- How are cost overruns measured?
- What has been the DoD's response to cost overruns over the years?

Subsequent chapters will then discuss the methodology used to test the three hypothesis, will present the results of that analysis, and will discuss the findings of this research effort as they apply to the Department of Defense. Finally, recommendations will be made for further research.

II. Literature Review

Chapter Overview

Researchers have conducted numerous studies over the last 30 years in an effort to capture the driving force behind a cost growth "phenomenon". These studies have attempted to quantify, predict, measure, and control cost growth, yet current research leads us to believe that our predictions have failed as have our most of our attempts to control it. While some studies may have produced more effective models than others the bottom line remains...we still know little about cost growth, and we're still confused over what causes it (Drezner and others, 1993; Wilson, 1992:8). This is significant because of the pervasive nature of cost growth. While the Department of Defense can run stable programs it is the exception not the norm (Gansler, 1989:126). In other words, cost overruns are expected. Eugene Scott's opening remarks of a National Contract Management Journal article are summarily appropriate:

> Probably the most troublesome, difficult, and obstinate problem in the execution of major projects is the phenomenon of cost growth. (Scott, 1983:1)

The objective of this research is to determine if the policies implemented as a result of the 1986 Packard Commission Study have been effective in reducing cost overruns. This chapter summarizes a number of published works and addresses them in a manner which seeks to not only prepare the reader for resolving the overall research objective but to also clarify some of the misunderstandings that have surrounded the study of cost growth. The literature relates to the following areas and will be discussed in the order listed:

- The importance of cost growth studies to the Department of Defense
- Factors affecting cost growth.
- The measurement of cost growth.
- The Department of Defense's response to cost growth.
- The Packard Commission study.

The Importance of Cost Growth to the Department of Defense (DoD)

Before one can begin to address the issue of cost growth a common definition of the variable to be measured must first be established. Much of the current literature in this area uses the terms "cost growth" and "cost overruns" interchangeably and neglects to differentiate between the two. However, the terms are, in fact, different, and this paper attempts to distinguish between the two terms and will discuss that difference in detail later in this chapter. Simply speaking, cost growth is measured as the difference between the actual costs (or the most current estimate of actual costs) and the initial estimate established at the start of a system's development (AFSC, 1988:A-22). A cost overrun is measured as the difference between the total budget for all the work on the contract and the estimated final cost of the contract (Christensen, 1993:44). Whether one is talking about cost growth or cost overruns the underlying notion is the same. The phenomenon refers to the tendency for the unit cost of a system to increase during the course of the acquisition process (Singer, 1983:2).

This cost increase is the focus of this thesis and has been the focus of numerous studies over the years. At least ten AFIT theses covering cost growth research have been written in the last decade and for more than 25 years RAND has studied topics such as cost growth estimation and cost control and has analyzed almost every type of military weapon and support system except Navy ships.

The majority of these cost growth research studies reference Cost/Schedule management and Cost/Schedule Control Systems Criteria (C/SCSC) as the tools used to analyze cost and performance data and to provide visibility into cost and schedule progress. Under acquisition reform this system has evolved into what is now called "Earned Value Management (EVM)". "Earned Value Management emphasizes the integration of the cost, schedule, **and** technical to support decisions by program managers " (ACQ 201, 1997:251). This integration then allows program managers to evaluate programs more thoroughly and objectively. The EVM System is, in essence, a broader application of the former Cost/Schedule Management System, and it, like C/SCSC, establishes a set of standards for effective management systems. These standards constitute a fairly rigorous test of a contractor's management techniques, and the DoD requires contractors reporting cost and performance data to conform to them. One key aspect of this system is that "contractors use their own internal integrated management system to manage and report to the government" (ACQ 201, 1997:254). If this type of criteria compliant system is used properly "it ensures that valid cost, schedule and technical progress information provide the manager with an effective tool for decision making"

(AFMCP 173-5, 1997). The purpose of the system is to standardize performance data reporting, to provide the contractor and the Government Program Managers with accurate and reliable data to monitor execution of their program, and to provide a basis for responsible decision making (DODI 5000.2, 1996:Part 3,9).

Undoubtedly, cost growth is a popular topic and it's easy to see why. In the mid 1980's perceived inefficiencies in the DoD's procurement system were at their peak (Griffiths, 1985; Gates, 1989). Stories of the Pentagon paying $400 for an $8 claw hammer shoved these inefficiencies into the spotlight as never before. On an average workday in the 1980's the Pentagon wrote approximately 52,000 contracts which works out to about 15 million contracts each year (Griffiths, 1985:144; Gansler, 1989:4). Furthermore, the DoD was spending around $300 billion a year (Gansler, 1989:4). During this period when public pressure on controlling defense spending was at its peak critics estimated that in one year alone sloppiness, duplication, and fraud could add up to $23 billion which was about one third of total weapon procurement expenditures (Griffiths, 1985:144). From FY 1991-1996 the DoD spent, on average, $135 billion on procurement and wrote approximately nine million contracts a year (DIOR, 1997). While these levels are considerably lower than those in the 1980's the magnitude of DoD procurement activities remains significant, and over the last two decades it seems one is constantly hearing though the media that some defense program will cost taxpayers millions of dollars more than was budgeted.

These unplanned cost increases are of interest to both public and private organizations (Gaston, 1992:Part II;Gansler, 1989:Ch 1). A 1993 Rand Corporation study discussed the extent of cost growth in the DoD. Those results indicated that cost growth has fluctuated around 20 percent since the mid 1960's and that little improvement has occurred over time (Drezner and others, 1993:2). Other research indicates that the average cost overrun on DoD acquisition contracts is approximately 40 percent (Gansler, 1989:4). However one measures the unplanned cost increases (growth or overruns) is academic; the magnitude of the problem persists and is readily seen as 20 to 40 percent can represent a notable loss. For example, a significant contract, as defined by Earned Value Management Systems Criteria (EVMSC), will be at least $70 million (in constant FY'96 dollars) for a research, development, test, and evaluation contracts. Significant procurement contracts are those with estimated values of at least $300 million (FY'96 constant dollars)(DoDI 5000.2, 1996:Part 3,9-10). Table 1 displays the enormity of cost growth or overruns on $70 and $300 million contracts across varying growth rates. The effect of a 10 to 50 percent cost overrun could easily range from $7 million to $150 million, and this represents the low end of the spectrum as these contracts just satisfy the significance threshold established in DoDI 5000.2.

Table 1. Cost Growth Across Varying Growth Rates

% Increase	$70 Million	$300 Million
10%	$ 7 million	$30 million
15%	$10.5 million	$45 million
20%	$14 million	$60 million
25%	$17.5 million	$75 million
30%	$21 million	$90 million
35%	$24.5 million	$105 million
40%	$28 million	$120 million
45%	$31.5 million	$135 million
50%	$35 million	$150 million

Thus, the significance of the cost impact is apparent, but the issue of cost is not the only concern to the DoD. "Cost growth forces the DoD to revise budget plans, makes systems less affordable, and frequently erodes congressional support for acquisition programs" (Tyson and others, 1994:I-1). Furthermore, it affects the quality of decisions concerning U.S. defense policy (Drezner and others, 1993:1). It is also important to the DoD for the following reasons:

- It affects the fielding of a system.
- It affects the defense industrial base.
- It affects the common welfare of the people.

<u>Cost Growth Affects the Fielding of a System</u>. Unplanned increases in cost have to be offset somewhere. One of these offsets is often reflected in the schedule. Because of inadequate funding schedules often have to be slipped (Marciniak, 1990:213). This view is also mentioned by Gansler who states that

"as increasing costs confront a fixed or declining budget the only way to fit the higher costs into the budget is to stretch out the program, by extending its development time and/or by buying fewer production units each year"(Gansler, 1989:121). There don't appear to be a number of options available to offset the unplanned costs, and the argument is fairly simple. As costs escalate the DoD offsets the increase by stretching out schedules or by buying lesser quantities. Both of these responses affect the fielding of the system and contravene DoD acquisition policy. "The primary objective of the defense acquisition system is to acquire quality products that satisfy the needs of the operational user with measurable improvements to mission accomplishment, in a timely manner, at a fair and reasonable price" (DODI 5000.1, 1996:3). Cost growth hinders the attainment of that objective by delaying the provision, thereby leaving U.S. forces without needed capabilities, or by providing lesser quantities than what is required in the field. As Gansler states, "..overall military effectiveness is not measured only in terms of a single weapon's performance, quantities matter, too" (Gansler, 1989:172). He also states that "many military theorists argue that quantity has an even greater effect than individual weapon performance" (Gansler, 1989:172).

Cost Growth Affects the Defense Industrial Base. The reduced quantities produced as an offset for cost overruns can also affect the defense industrial base. Over the years there has been a slow decline in the number of defense oriented firms, and this shrinking is warranted because of the reduction in the total volume being produced (Gansler, 1989:256). However, this smaller defense industrial base could affect overall efficiency and could also increase our country's dependency on foreign suppliers which could place the United States in a difficult position in times of war. Since World War II "there has always been a concern about the availability" and the dependability of obtaining materials from foreign sources, and a shrunken defense industrial base may find it difficult or impossible to timely provide sufficient resources in a period of crisis or conflict (Gansler, 1989:266; Weida, 1987:113).

Cost Growth Affects the Common Welfare of the People. One of the most difficult aspects of budgeting is establishing priorities. Our nation's people, as a whole, have an indirect voice in how the country's priorities are established by voting for elected officials they feel best represent their desires for certain public goods such as national defense or education. Cost overruns result in only two options: either funding is drawn away from other public goods in order to fund the defense good or the defense good must be foregone. In either case the public's needs may not be satisfied. Public opinion on the costs of defense has always been tense. Consider President Eisenhower's remarks in April 1953 concerning the futility of military spending.

> *-"Every gun that is made, every warship launched, every rocket fired signifies, in the final sense, a theft from those who hunger and are not fed, those who are cold and are not clothed...*
> *-The cost of one modern heavy bomber is this: a modern brick school in more than 30 cities.*
> *-It is two electric power plants, each serving a town of 60,000.*

It is two fine, fully equipped hospitals.
-It is some 50 miles of concrete highway.
-We pay for a single fighter plane with a half million bushels of wheat.
-We pay for a single destroyer with new homes that could have housed more than 8,000 people." (Gaston, 1992:91-93)

Gansler refers to this debate as a "guns versus butter" debate, and states that the issue has "become a dominant issue during periods of peace since the end of the Korean war" (Gansler, 1989:79). This line of public thought considers heavily the tradeoff between defense goods and other public goods. Because this competition exists between the two one needs to consider that people are only willing to sacrifice so much of the national output for defense spending (Peterson,1988: 702). Cost overruns upset the "balance" of public opinion. At some point the public, through their elected officials, will refuse to support programs experiencing cost overruns. These programs, as public goods, may be canceled.

These unplanned cost increases could easily add up to hundreds of millions of dollars, but perhaps more important are the consequences cost growth may force on the operational user and on this country's citizenry. The magnitude of this procurement phenomenon may signal cost growth as one of the acquisition system's chief concerns. It's certainly a significant problem in tight budget environments (Drezner and others, 1993:xi). Identifying possibly factors affecting cost growth may lead decision makers to a better understanding of the problem and may provide them with improved remedies for mitigating its effects.

Factors Affecting Cost Growth in the Department of Defense

When the public considers the reasons for cost growth normally the first impression that comes to mind is that "cost growth is the result of overruns because of gross mismanagement" (Scott, 1983:38). While it is true that mismanagement or other inefficiencies are sometimes involved most often these factors are responsible for only a relatively small portion of the cost growth (Drezner and others, 1993:xi-xv; Scott, 1983:37-38; Weida, 1987:Ch 9). It's difficult to understand all of the factors which lead to increased costs, and, unfortunately, only the widely publicized and readily grasped factors such as fraud or mismanagement tend to get undue attention (Weida, 1987: Ch 8; Griffiths, 1985). Actually, the minor sins of fraud, waste, and abuse "cost the taxpayer only a fraction of the amount generated by other inefficiencies" (Weida, 1987:145). Table 2 shows a number of possible factors identified as affecting cost growth (Scott, 1983). Independently these factors may cause cost growth, but usually one or more (or a combination of many) are the real causes (Scott, 1983:38).

Table 2. Factors Affecting Cost Growth

Planning Difficulties	Risk Elements	Management Inefficiencies
1. Incomplete Definition of Work	6. Unforeseeable Conditions	11. Disorganized Work Direction and Productivity
2. Interface Incompatibilities	7. Unpredictable Regulatory or Funding Delays	12. Subcontracting
3. Changes; Failure to Anticipate Needs	8. Unforeseen Technical Difficulties	13. Unnecessary Work or "Gold Plating"
4. Estimating Uncertainties; Poor Estimating	9. Uncontrollable Forces	14. Project Control
5. Optimistic Assumptions	10. Unanticipated Economic Conditions	15. Work Load Projections

The factors represented in the planning difficulties category are those that tend to prevent realistic early assessments of the final costs of projects. For example, budgets and estimates are established during the planning stages of a project while the project is still in the process of being defined. However, defining a project can be "carried initially only to a point of verifying feasibility and defining basic requirements, but must stop short of including complete detail" (Scott, 1983:38). So, contractors often find themselves in a "catch 22" situation wherein if they spend too much time defining a project to ensure accurate estimation overall costs will rise as schedules are extended, and if they define projects inadequately or incompletely estimations of costs are difficult to determine as rigorous estimates require a good definition of the work. In addition it's sometimes impossible to project future requirements even for a few years.

Political, international, and cultural forces, what Scott calls the natural evolution of progress make changes inevitable and unpredictable (Scott, 1983:45).

The risk element factors are those that are more inherent in the system; that is, they are not controllable nor are they predictable. Risk factors "are those adverse possibilities which cannot be reliably anticipated. These are potentialities that may occur or they may not, and there is no reasonable way to take appropriate preventive measures" (Scott, 1983:41). No matter how good our estimating models are or how thorough our planning process is conditions can still arise that can't be reasonably foreseen. Technological change is one condition that arises that is often unforeseeable yet tends to drive costs up. Many decision makers believe that "the best way to start and to defend successfully a weapon development program is to employ the most advanced technology available. Unfortunately, this is also the best way to guarantee that the costs associated with that program will be high" (Weida, 1987:152-153).

The last category, management inefficiencies, contains those factors mentioned previously. These are the factors that are considered to be controllable by management. Any cost overruns that are actually caused by mismanagement fall in this category. Proper managerial action may avoid some of the overruns resulting from these causes, but it's doubtful that all of it could be eradicated as management inefficiencies are bound to exist (Scott, 1983:38-45).

This breakdown is similar to that identified in other cost growth research. Similar studies have identified the following factors as other potential causes of cost growth:

1. Not adequately budgeting for risk and uncertainty (particularly during the relatively high risk research and development phase)
2. Unexpected high inflation
3. Supply and demand factors
4. Poor resource allocation
5. Managerial inefficiency
6. Technological uncertainty
7. System requirements uncertainty
8. Less than perfect cost estimating techniques
9. The budget process involving risk in congressional appropriations.
10. Program length, size, and maturity (Drezner and others, 1993:xiii) (Woodward, 1983:13).

It's natural to question the efficiency of the acquisition process because the DoD's procurement budget is so large. As stated previously, the DoD spent upwards of $300 billion a year on various programs in the 1980's and spends close to $140 billion a year in the 1990's. We've also demonstrated where even a small inefficiency could translate into substantial amounts of wasted funds. Unfortunately, there aren't any indices that directly measure procurement inefficiencies, so analysts are forced to use quantitative measures of program outcomes, such as cost growth, as proxies for inefficiency (Gates, 1989:9). Over time, cost growth, as a proxy, has come to be viewed as a program inefficiency, and reforms have addressed it rather than the underlying causes (Gates,1989:9). However, cost growth may not signal an inefficiency in the program. For example, if a program is managed efficiently but the initial estimate was low then cost growth isn't necessarily inefficient, and if the initial estimate was excessive than the absence of cost growth may not indicate program efficiency. It's important to remember that cost growth is only a proxy which makes it difficult to determine if program inefficiencies are truly significant, and any reform efforts the DoD implements need to fix the problem not just the symptoms.

As stated earlier, cost growth could result from mismanagement, fraud, waste, or abuse which is consistent with the view that cost growth is a direct indication of program inefficiencies. Gates reports that the appropriate response, in this case, "is to improve DoD's cost management capabilities" (Gates, 1989:10). This would include measures such as improving cost data, cost estimating techniques, and the qualifications of DoD's program managers. Reform efforts containing these measures may be successful if cost growth is the result of mismanagement and fraud, but they won't work if cost growth is merely a signal of other problems (Gates, 1989:9-11).

Also, the impact of an organization's culture on cost growth can not be ignored. Organizational culture refers to the "broader values and normative patterns which guide worker behavior, practices and policies", and plays a crucial role as a mechanism of control (Flamholtz, 1983:158,168). An example of how culture affects cost growth can be seen in the case of the Navy's A-12 program. The information the program manager reported up the chain of command was always cast in a positive, optimistic light. Rather than highlighting risks "in a system which depends upon information being pushed up from the bottom," he viewed unfavorable variances through "rose colored" glasses and chose to continually report how "things would get better" (Beach, 1990:41). Unfortunately, this is a by-product of the control system (Flamholtz, 1983:168). The same performance measurements use to evaluate the system are also used to evaluate the performance of individuals and often results in a "shoot the messenger" mentality. Managers may then make the more parochial, short term decisions, or in the case of the A-12 Program Manager, may continually report overly optimistic information for fear of poor evaluations. Note, however, this type of behavior is not unique to the Navy and can be generalized to other services. In the Navy A-12 inquiry report the inquiry officer concluded, in part:

> *There is no reason to believe that the factors which made these officials [the A-12 managers] choose to respond the way they did are unique to this Military Department. Indeed, experience suggests that they are not. Unless means can be found to solve this abiding cultural problem, the failures evidenced in this report can be anticipated to occur again in the same or a similar form.* (Beach report, 1990:41)

Another possible cause of cost growth not already discussed concerns the initial estimation process. Inadvertent or intentional underestimation of initial costs will lead to cost growth. The first explanation has often been referred to as the "winners curse" (Quirk and Terasawa, 1984). At the beginning of an acquisition program the development and procurement costs are uncertain, yet contractors are forced to estimate their expected costs which are then used in the selection process. If all of the other evaluation factors are equal the contractor selected will be the one who underestimates his cost the most.

Underestimation in this case is caused by uncertainty and is entirely inadvertent, yet "this introduces a selection bias toward programs with a predisposition for cost growth, even though the program may be conducted efficiently" (Gates, 1989:10). Gansler also reports that "the system encourages a great deal of "optimism" in bidding and in budgeting" (Gansler, 1989:177). The winning contractor is one who, all other factors being equal, bids the lowest amount. Cost growth, in this case, doesn't signal an inefficiency in the program, but it may signal that there are inefficiencies in the selection process (Gates, 1989:10). Any reform measures attempting to improve cost management capabilities in this situation would not be effective. The second explanation results from competition and is often referred to as "buying in". Competitive pressures encourage contractors to make overly optimistic cost estimations during the proposal process. Gansler points out that the evaluators know that awards will be "subjected to enormous public scrutiny, and will attempt to take the safe route by making the award to the contractor who promises the most and offers the lowest price" (Gansler, 1989:179-180). There is an intense pressure on the contractors to compete vigorously as very few major weapon system programs are initiated in a decade, for example. In this case initial cost underestimation is intentional rather than inadvertent, and any reform measures appropriate in these instances must be different than in the earlier situations in order to be effective (Gates, 1989:9-13).

Program turbulence is often thought of as another cause of cost growth (Drezner and others, 1993; Gansler, 1989:Ch 6, Gates, 1989). Program turbulence is a term used to describe changes or modifications made to a program such as production rate changes, schedule changes, or changes in end-items required (Gates, 1989:10-11). However, Gates points out that program turbulence is actually a symptom of other problems and not a cause of cost growth. He reports that unanticipated inflation and increases in the contractor's unit cost estimates lead to funding shortfalls, and that these shortfalls cause production schedule changes. Furthermore, unexpected technical problems, changes in the total procurement objective, and program funding changes also lead to changes in the production schedule (Gates, 1989:11). These changes, however, may not be bad. "In fact, program turbulence may be an efficient response to unavoidable and unpredictable changes in national priorities, the defense environment, or the program itself" (Gates, 1989:11). The impact of changes must also be considered. One AFIT study tested the popular assumption that changes on defense contracts are correlated with poor cost performance. However, the results of that study did not support that assertion. The results failed to show evidence that the hypothesized relationship between changes and cost performance existed (Gordon, 1996). The bottom line is that change may not be bad. Together, these studies lead us to believe that:

1) program turbulence (changes) may not lead to higher cost growth, and

2) program turbulence may be an efficient response to unavoidable and unpredictable change.

Therefore, if this is the case, any reform measures attempting to remove program turbulence or stabilize high priority programs should be carefully viewed. Any interventive efforts may simply "shift the burden of adjustment to unprotected programs", and the added costs of turbulence in these programs needs to be considered (Gates, 1989:11).

The factors causing the cost growth problem need to be, first, identified in order to control or solve the problem. Once these causal factors have been determined steps can then be taken to implement policies and other reform measures aimed at eliminating, reducing, or stabilizing the causes. One needs to remember, though, that cost growth is only a proxy which makes it difficult to determine if program inefficiencies are truly significant, and any reform efforts the DoD implements need to address and fix the underlying problems not just the symptoms.

The Measurement of Cost Growth

Cost growth can be measured in a number of different ways, and literature presents different uses of the term. One runs across the terms cost growth, cost variance, and cost overruns when reviewing studies in this area. It seems the terms "cost growth" and "cost overrun" are often used interchangeably, but they are in fact referring to different measurements. This may lead to misunderstanding and confusion among policy makers, program managers, and contractors who are unaware of the difference. Furthermore, it makes it difficult to compare available research work and studies because the term is not standardized (Sapp, 1971:15).

Cost Growth. "Cost growth can be defined simplistically as the difference between estimated and actual costs" (Drezner and others, 1993:1). As defined in the AFSC Cost Estimating Handbook, cost growth is measured as the difference between the actual costs (or the most current estimate of actual costs) and the initial estimate established at the start of a system's development. It is a term "related to the net change of an estimate or actual amount over a base cost figure previously established" (AFSC, 1988:A-22). Therefore, the total cost growth of a contract is simply calculated as shown in Equation 1 by subtracting the initial cost estimate from the estimate at completion.

$$\text{Cost Growth} = \text{EAC} - \text{initial estimate} \qquad (1)$$

Cost Overruns. The terms cost overrun and cost variance refer to same measurement (Christensen, 1993:44). Specifically, a cost overrun is simply an adverse cost variance. The formula for calculating cost variance is found in Air Force Systems Command Pamphlet (AFSCP) 173-4, Guide to Analysis of Contractor Cost Data and is calculated by subtracting the actual cost of work performed (ACWP) from the budgeted cost of work performed (BCWP) (AFSCP, 1989). Christensen states the formula differently but achieves the same results.

He writes that "the overrun at completion is the difference between the total budget for all the work on the contract, termed the "Budget At Completion" (BAC) and the estimated final cost of the contract, termed the "Estimate At Completion" (EAC) (Christensen, 1993:44). This is the same formula as the BCWP of a completed contract equals the BAC, and the ACWP of a completed contract equals the EAC. This is demonstrated below in Equation 2.

$$\text{Cost Overrun} = \underset{\text{(BAC)}}{\text{BCWP}} - \underset{\text{(EAC)}}{\text{ACWP}} \qquad (2)$$

<u>**Cost Growth Versus Cost Overruns**</u>. It's important that one understands the difference between the two measures. Figure 1 provides a graphic description of cost growth as we now understand it. The cost growth of a completed contract will capture the unplanned cost increases occurring as a result of low estimations, changes to the contract, and any management inefficiencies. Figure 2 shows a similar model for cost overruns. The key feature of the cost overrun model is the use of the <u>current budget</u> as opposed to the initial estimate used in the cost growth model. As a contract progresses budgets are revised and updated, and these "current budgets" are then recorded as the BCWP. As a contract progresses any costs from changes and modifications are, therefore, absorbed in these updated budgets; thus, a cost overrun would only reflect increases caused by low estimations or possibly mismanagement of some sort. We understand from Gates' research that changes (or turbulence) in the contract is not necessarily inefficient, and Scott leads us to believe that a number

of changes are due to unforeseeable risk elements which cannot be planned for anyway. Furthermore, the conclusions drawn from Gordon's thesis suggest that modifications don't appear to be highly correlated with cost growth. For these reasons it is my opinion that the use of the cost overrun model is more appropriate as a measurement of unplanned cost increases. This thesis recognizes the contributions made by both models, but the cost overrun model will be used as the measuring tool throughout this study.

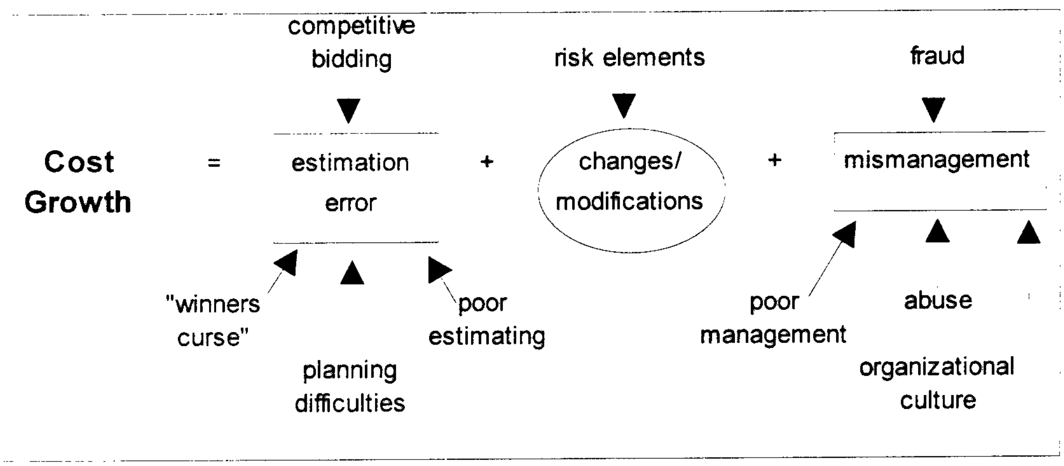

Figure 1. Cost Growth Model

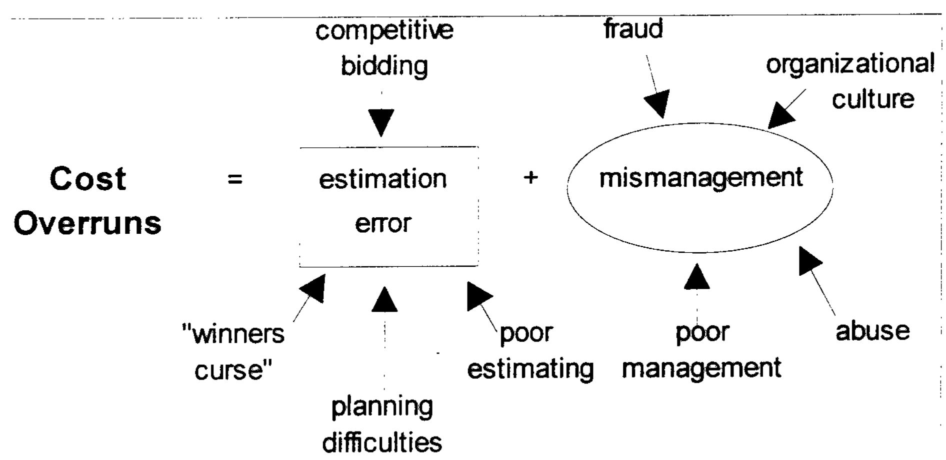

Figure 2. Cost Overrun Model

The Department of Defense's Response to Cost Growth

As stated previously, for several years the Department of Defense has recognized that cost growth in weapons systems is a problem. In fact, regulations to control defense procurements extend as far back as the 1940's. The Armed Services Procurement Act of 1947 was essentially the first formal unified defense procurement policy to be established (Gates, 1989:2; Gansler, 1989:179). Early procurement reform efforts in the DoD focused on coordinating procurement reform among the services. The various service's mission were ambiguous, inter-service competition was high, and in a number of areas weapons programs overlapped (Acker, 1980; Gates, 1989). Drezner discussed cost growth trends in a Rand study entitled, An Analysis of Weapon System Cost Growth, and showed where several attempts have been made over the years to improve cost performance. Table 3 is an excerpt from that study and shows some of the more important regulatory and administrative initiatives implemented over the last 25 years that were intended to improve cost performance in weapon system development (Drezner and others, 1993:28-29). Some of the more recent regulatory and administrative initiatives have been added to Drezner's list.

Table 3. Acquisition Regulations & Initiatives Over The Years

Year	Regulations / Initiatives
1969	Packard initiatives published
1970	
1971	Blue Ribbon Defense Panel (Fitzhugh Commission)
1972	DoDD 5000.1 (Major System Acquisitions); Commission on Govt Procurement
1973	DoDD 5000.4 (CAIG); DoDD 5000.3 (T&E)
1974	
1975	DoDI 5000.2 (Major System Acquisitions); DoDD 5000.28 (DTC)
1976	OMB Circular A-109
1977	
1978	Acquisition Cycle task Force
1979	Defense Resource Mngt Study
1980	
1981	Carlucci Initiatives (AIP)
1982	Nunn-McCurdy (thresholds)
1983	Grace Commission
1984	CICA
1985	DoDD 5000.43 (streamlining)
1986	**Packard Commission**
1987	DoDD 5134.1 (USD(A)); DoDD 5000.49 (DAB)
1988	
1989	Defense Management Review
1990	
1991	Revised DoDI 5000.2 (Major System Acquisitions)
1992	
1993	
1994	Federal Acquisition Streamlining Act (FASA)
1995	Federal Acquisition Improvement Act (nicknamed FASA II)
1996	OMB Circular A-76

In the 1960's, Under Secretary of Defense McNamara's direction, quantitative measures of program performance became more important and showed that cost growth was becoming increasingly significant (Gates, 1989:3-4;

Enthoven, 1971). As a result, from 1961-1969, McNamara introduced a number of initiatives aimed at reducing and controlling cost growth. However, cost growth, perceived as an inefficiency in the procurement process, continued through the 1970's, becoming more and more prevalent. At that time it was generally acknowledged to be a problem in the DoD. Excessive competition was one of the most frequently cited causes for problems such as cost growth and schedule delays (Gates, 1989:4). David Packard, Deputy Secretary of Defense (DEPSECDEF) who took office in 1969 along with Secretary of Defense Melvin Laird, published a set of initiatives which had considerable impact on acquisition policy (Dews, 1979:1). These initiatives were believed to have had a profound effect on cost growth. In fact, a 1979 Rand Corporation study, Acquisition Policy Effectiveness: Department of Defense Experience in the 1970's showed that cost growth for major weapon systems averaged approximately 8% in the 1960's but decreased to approximately 7% in the 1970's (Dews, 1979:56).

However, "when Frank Carlucci became the DEPSECDEF in 1980, alleged acquisition inefficiencies (cost growth, schedule delays, and performance shortfalls) continued to plague the defense acquisition process" and Congress and the General Accounting Office were becoming increasingly concerned about cost growth (Gates, 1989:6). What was thought to have been controlled in the 1970's (cost growth) resurfaced as a pressing problem in the 1980's. In fact, cost growth in the 1980's seemed to be increasing (Singer, 1983:2; Drezner and others, 1993:30). Looking back at the alleged success of reduced cost growth in the 1970's Drezner found that the differences in the average age of programs largely accounted for the apparent improvement and that programs tended to incur more cost growth as they matured because of accumulated problems. "Taking that into account, it appears that, on average, weighted average total program cost growth has been fairly constant over time, averaging around 20 percent" (Drezner and others, 1993:30). It appears that none of the regulatory and administrative initiatives implemented in the 60's, 70's, or early 80's were successful in reducing cost growth in major weapon system contracts.

The Packard Commission Study

The Packard Commission was established by President Reagan in an effort to combat the still pervasive inefficiencies in the DoD's procurement system and to stimulate procurement reform. In the mid 1980's cost growth, schedule delays, performance shortfalls, and high unit procurement costs were still perceived as major problems in the acquisition process (Gates, 1989:6-8). The group, officially called the President's Blue Ribbon Commission on Defense Management, was informally named after its chairman, industrialist and former DEPSECDEF David Packard. They examined DoD management in general but concentrated particularly on the acquisition process.

William J. Perry, former Under Secretary of Defense for Research and Engineering and a member of the Commission stated that, "the primary conclusion of the Packard Commission was that defense acquisition was unacceptably inefficient. Specifically, major weapons systems cost too much, take too long to field and by the time they are fielded incorporate obsolete technology" (Nordwall, 1987:80). He also reported the problems didn't appear to be the result of deviations from or abuses of the system but were direct consequences of the system itself. A GAO report authored by the Subcommittee on Defense Industry and Technology pointed out that the Commission found the DoD's acquisition system had become an "increasingly bureaucratic and over-regulated process in which acquisition policy-making and program management responsibility were fragmented and diluted" (GAO, 1991:1-2). The Commission reported that the acquisition system had become so highly competitive that program managers, because of internal and external pressures, became "supplicants of, rather than managers of, major new defense systems" (GAO, 1991:2). Perry commented that these competitive pressures resulted in a "huckster" environment that led program managers to optimistically interpret information about a system's cost, schedule, and performance (GAO, 1991; Nordwall, 1987:80-81). These remarks echo those made in the Beach report regarding the organizational culture described earlier regarding the Navy A-12 program. Because of this culture of optimism programs inevitably ended up with understated costs and there was a high incident of cost overruns on major weapon systems programs.

The Commission concluded that the primary problems with the acquisition process were the same inefficiencies of the 60's and 70's, namely cost growth, schedule delays, and performance shortfalls. It's important to note that the Commission believed these inefficiencies were actually the problems and not just symptoms. Recall from the discussion earlier in this section that for reform efforts to be effective they must address the root problem not just fix the symptoms. This seems to be the first time that symptoms and problems were differentiated. They also believed that the perceived causes of these problems were program instability, lengthening acquisition schedules, "gold plating", and program "buy-ins" (Gates, 1989:7).

The Packard Commission offered a number of recommendations to alleviate these problems. Essentially, the Commission's report "boiled down" to the following recommendations:

- streamlining the acquisition process
- increasing tests and prototyping
- changing the organizational culture
- improving planning
- adopting the competitive firm model where appropriate

President Reagan endorsed the Packard Commission's recommendations in the National Security Decision Directive 219 in 1986 and they were incorporated in the Defense Reorganization Act (Gates, 1989:7; GAO, 1990:1).

The Packard Commission's study did not appear to break new ground. Actually, their reform recommendations are strikingly similar to previous reform efforts (Gates, 1989). The natural question to ask at this point is whether or not the recommendations were effective at reducing any of the perceived inefficiencies of the DoD's acquisition system. Specifically, were cost overruns reduced as a result of recommendations implemented as a result of the Commission's study?

Cost overruns could result from mismanagement or fraud; although, we noted that only a small portion of cost overruns actually seem to fall in this category. This view would be consistent with the thinking that cost overruns are a direct indication of program inefficiencies. Recall that the appropriate response in this case would be to improve DoD's cost management capabilities and to improve the planning process. The Commission's recommendations seem to imply that cost overruns are actually caused by mismanagement or fraud. Furthermore, it appears that the intent of the Commissions recommendations was to nourish a new acquisition culture within the Department of Defense so that decisions on purchasing major weapon systems were based on realistic program information. If this is actually the case (that overruns are due to management inefficiencies) we would expect cost overruns to decrease as a result of these reform measures. However, it is important to understand that these measures will not reduce cost overruns if they are caused by selection biases, over-optimistic projections, or some other factor.

In a GAO report from the National Security and International Affairs Division to Senator William Roth it was reported that President Bush, in February 1989, directed the Secretary of Defense to develop a plan to fully implement the Commission's recommendations, as well as to substantially improve defense management overall (GAO, 1990:1-2). As a result, in July 1989, the President approved and the Secretary issued the Defense Management Report (DMR) which outlined actions needed to improve DoD management. This 1990 report stated that the DoD's efforts to implement the DMR initiatives were in various stages. It stated that a number of initiatives were already underway and that the remaining initiatives were all planned for implementation in the near term. A 1991 GAO report by the same office stated that most of the recommended changes to the acquisition system had been made; however, it also pointed out that it was unclear whether the initiatives alone would bring about the cultural transformation intended by the Packard Commission (GAO, 1991). The report noted that "the success of these changes will also depend on strong central leadership from the Secretary of Defense, strengthened internal controls in the acquisition decision-making process, and the free flow of information both up and down the organization" (GAO, 1991:1-2).

The problem of cost overruns is multifaceted, but researchers believe that progress can be made by attacking its various aspects. One must understand, though, that the phenomenon of cost overruns (or cost growth for that matter) is not likely to be entirely eliminated by partial solutions although they can be very helpful in reducing the proportions of cost growth exposure (Scott, 1983:45). "Some of the unpredictable aspects of cost growth and the psychological factors involved are uncontrollable in nature, and in some respects are linked to the inevitability of progress" (Scott, 1983:45). Nevertheless, the Department of Defense must make continuing efforts to minimize cost overruns on major weapon system programs by exercising proper planning and management techniques and by promoting a better understanding of the root causes of cost overruns.

Summary

The phenomenon of cost overruns in the Department of Defense has been a problem for decades. In fact, regulations to control defense procurements extends as far back as the 1940's. These unplanned cost increases in the DoD's weapon system procurements can escalate to staggering amounts and can impact not only the operational users but the people of this country as well. Furthermore, cost growth can affect our national security. Unfortunately, cost growth has persisted despite numerous attempts to control and mitigate it. Some confusion over the magnitude of the problem can be traced to how researchers have typically measured it. Some studies have measured cost growth while others have measured cost overruns, but these measures are clearly distinct. Decision makers need to understand this difference when determining whether a cost growth of 20 percent or a cost overrun of 40 percent is significant and signaling an inefficiency as the two measures are entirely different. Cost growth, unlike the cost overrun model, incorporates cost increases due to risk elements and change. Not only are these elements unavoidable, but studies have shown no correlation between these changes and poor cost performance. For this reason this study will use the cost overrun model as it represents a more realistic and practical measurement. It's practical because it measures cost increases resulting from controllable factors. In other words, it allows the DoD to concentrate on problems it can do something about.

In light of the information presented, though, one should consider the nature of the recommendations made by the Packard Commission. The recommendations seem to focus on correcting perceived management inefficiencies suggesting that cost growth results from mismanagement or fraud. These recommendations are strikingly similar to past reforms (Gates, 1989:7). Thus, two major concerns arise. First, we've shown that little progress has been made over the years in reducing the problem of cost growth. Studies have indicated that cost growth has fluctuated around 20 to 40 percent since the mid 1960's and little improvement has occurred over time. If the Packard recommendations are similar to prior reform efforts which were ineffective should the DoD realistically expect improvements in cost performance? Secondly, one should be concerned about the focus of the recommendations. The recommendations made by the Packard Commission seem to focus on management inefficiencies as the primary factor affecting cost growth. However, studies have shown that the minor problems of fraud, waste, and abuse, or simply poor management, actually account for only a relatively small portion of the cost growth (Drezner and others, 1993:xi-xv; Scott, 1983:37-38; Weida, 1987:Ch 9). If management inefficiencies represent such a small portion of the problem why is the focus of the Commission's reform efforts on them? Perhaps the DoD's reform efforts would be more effective were they focused more on overcoming the various planning difficulties.

Propositions

Although the Packard Commission released their recommendations in 1986 the two GAO reports from the National Security and International Affairs Division suggest that the recommendations were not substantially implemented until 1991 (GAO, 1990; GAO, 1991). This thesis proposes to test the following propositions to show that the recommendations implemented as a result of the Packard Commission study are having little to no effect on reducing cost overruns on major weapon system contracts.

- *Proposition*: Cost overruns for completed contracts before and after 1991 are essentially the same. The Packard recommendations are similar to past reform efforts which have been ineffective, and they appear to target those factors accounting for a relatively small portion of cost overruns, namely, management inefficiencies.
- *Proposition*: The recommendations will affect contracts differently based on contract phase, that is, whether the contract is for development or production. While significant changes (reductions) are not expected to occur as a result of the recommendations, the policy changes are expected to have a greater impact on contracts in the development phases than on those the production phases.

The presence of cost overruns is a recurring problem in the DoD, and the study of possible effects resulting from the implementation of acquisition reform efforts such as the Packard Commission study could alter this trend. In the following chapter the propositions listed above will be more clearly delineated in the form of hypothesis which can be tested using the presented methodology.

III. Methodology

Overview

This chapter describes the methodology used to answer the investigative questions forwarded in Chapter I. Recall the basic hypothesis is that cost overruns were reduced as a result of the changes implemented from the Packard Commission's recommendations. This study relies on the comparison of means as the statistical method employed to determine if differences exist in the population means before and after the changes were made. As such, the methodology structure is based on an *ex-post facto* pseudo-experimental design, or simply a pre-test - post-test experiment with no control group relying on archival data. A similar approach was used effectively in a 1993 study examining cost overruns between two populations of contracts (Wandland & Wickman, 1993).

Data Collection

The method applied in this study relied on data contained in the Defense Acquisition Executive Summary (DAES) database. This database is maintained by the Office of the Under Secretary for Defense for Acquisition & Technology (OUSD(A&T)) and contains cost performance data on completed contracts extending back as far as 1977 (DODI 5000.2, 1996:Part 6; Christensen, 1993:45; Wilson, 1992:42). Furthermore, every branch of the service reports summary cost data to the database. Because of this broad and extensive coverage the database can provide program managers with a valuable management tool which is precisely its intent. Specifically, "the purpose of the DAES report is to highlight both potential and actual program problems to the USD(A&T) before they become significant" (DODI 5000.2, 1996:Part 6). The DAES database available for this study contains cost performance data from 1977 though 1995.

Defense contractors regularly report cost data to the OUSD(A&T) using a number of cost management reports, one of which is the Cost Performance Report (CPR) The CPR is required to be submitted by contractors managing DOD contracts that require compliance with the Earned Value Management Systems Criteria. EVMSC establishes uniform evaluation standards for contractor's internal management control systems. Its purpose is to standardize performance data reporting, to provide the contractor and the Government Program Managers with accurate and reliable data to monitor execution of their program, and to provide a basis for responsible decision making (DODI 5000.2, 1996:Part 3,9; AFMCP 173-5, 1997). Furthermore, DODI 5000.2 states that this reporting is required of all significant contracts and subcontracts within all acquisition programs. "Significant contracts include research, development, test, and evaluation contracts and subcontracts with a value of $70 million or more or procurement contracts and subcontracts with a value of $300 million or more (in constant FY'96 dollars)" (DODI 5000.2, 1996:Part 3,10).

The data contained in the CPR's are summarized and sent on a quarterly basis to the OUSD(A&T) (DODI 5000.2, 1996:Part 6). This regular reporting ensures early indicators of contract cost and schedule problems are highlighted, and it displays "the effects of management action taken to resolve problems affecting cost and schedule performance" (DODI 5000.2, 1996:Part 6,11). The intent of this entire cost management program is to correct problems before they become serious. Timely analysis is the key.

The CPR contains a number of data fields four of which form the foundation of earned value measurement and cost performance reporting. These four principal fields are listed below and are defined according to the DSMC Glossary of Defense Acquisition Acronyms and Terms (DSMC, 1991). Later in this chapter equations will be presented demonstrating how these measurements are used to calculate the cost variance at completion ,or the Final Overrun (FO), and the Final Overrun Percentage (FO%).

Actual Cost of Work Performed (ACWP): The cost incurred and recorded in accomplishing the work performed within a given time period.

Budgeted Cost of Work Performed (BCWP): The sum of the budgets for completed work packages and completed portions of open work packages, plus the applicable portion of the budgets for level of effort and apportioned effort. This is also known as the Earned Value.

Budgeted Cost of Work Scheduled (BCWS): The sum of budgets for all work packages, planning packages, etc., scheduled to be accomplished (including in-process work packages), plus the amount of level of effort and apportioned effort scheduled to be accomplished within a given time period.

Budget at Completion (BAC): The sum of budgets for all work packages, planning packages, etc., for the entire contract excluding the management reserve budget.

Research Design

As discussed in Chapter II changes implemented as a result of the Packard Commission recommendations were substantially completed by 1991. As with similar policy changes as broad and encompassing as these there is no "on/off" switch; changes such as these occur over time, and it is nearly impossible to determine a precise date of implementation for the aggregate change (GAO, 1990; GAO, 1991). In 1990 Congress directed the General Accounting Office (GAO) to study and report on the DoD's progress in implementing the Packard Commission's recommendations and to determine whether the intended changes had occurred. The 1990 report stated that the DoD's efforts to implement the changes outlined in the 1989 Defense Management Report were in various stages, that a number of initiatives were already underway, and that the remaining initiatives were all planed for implementation in the "near term" (GAO, 1990:1-2). The second report dated

August 1991 stated that most of the recommended changes to the acquisition system had been made and the remaining changes would be completed in the short term (GAO, 1991). For the purposes of this study the Packard Commission recommendations are considered fully implemented as of December 31, 1991. This date is then set as the "cut-off" date for the treatment date and allows approximately four months (Sept - Dec 1991) for the remaining few changes to have been completed. The reader must understand that this date was selected judgmentally based on the available literature. Therefore, this study will compare the population of contracts completed before Dec.31,1991 with the population of completed contracts following that date. Specifically this thesis will use various statistical techniques to test samples from the two populations (before and after) in order to make inferences about the difference between population parameters if one exists.

Research Population

Using Dec 31, 1991 as our treatment date allows for approximately four years of post-treatment data to be included in this study. This study uses the DAES database to capture cost information on contracts completed in the period of January 1, 1988 to December 31, 1995. Any contracts not completed in this period were then eliminated from the population. This eight year period provides for approximately four years of pre and post treatment data, and the length of time should mitigate any potential bias due to factors such as fluctuations in the defense business cycle (Wandland & Wickman, 1993:28-29). A 1993 RAND study on cost growth briefly addressed the question of whether or not cost growth has improved over time. However, that study did not address the possible effects of the Packard recommendations, it had at most one to two years of data available, and it measured cost growth as opposed to cost overruns (Drezner and others, 1993). Furthermore, the time trend study used data only through 1989. As the Packard recommendations were not fully implemented until approximately December 1991 any possible effects would not be evident in that particular study. This study overcomes these shortfalls, and the results should significantly benefit policy makers. Also, only those contracts in the DAES database that reported a BAC and ACWP were retained as these cost figures are required to determine the final overrun. The contracts were then classified by program phase in order to answer the research questions and to test the hypotheses. Program phase was broken down into two phases: development and production. These two phases capture the "totality of system acquisition programs under this category. In DoD programs systems are either development or production with little or no discrepancy between them" (Wilson, 1992:48). As systems progress from the development to production phases the performance, schedule, and cost parameters become more predictable and less variable as the risks and uncertainties decrease over time. As a result the cost overruns should be distributed differently in the two groups. One would expect then that the policy changes would have a greater impact on contracts in the development phases than those in production phases. Any contract not specifying program phase was eliminated from the population as well. Less than one percent of the contracts completed in the eight year period of interest failed to report BAC or ACWP figures or specify program phase; furthermore, these few omissions were evenly distributed across development and production contracts and between the before and after groups. As such, selection bias is minimal and the results should be generalizable and externally valid.

Completed Contract Defined. This study limited the population of contracts examined to completed contracts. For the purposes of this study a completed contract is one that is at least 75 percent complete. An empirical examination of the DAES database suggests that many contractors discontinue CPR submissions when the contract is at or near completion. At approximately the 75 percent completion point and beyond contract cost performance is relatively stable (Gordon, 1996:Ch 3-4; Wilson, 1992:Ch 3). The majority of costs are incurred when a contract is from 15 to 75 percent complete. This is readily visible upon examination of the "S-curve" that is generated when the percent of costs incurred is plotted against the corresponding percent of contract completion (Weida, 1977). The "S" shaped curve represents the "normal ramp up and ramp down of a typical program" (Wilson, 1992:37). Figure 3 demonstrates this concept. Notice how the cost curve flattens out as the program nears completion. It may be for this reason that many contractors tend to discontinue submitting CPRs around the 75% completion point. Practically speaking the contract is nearly complete at this point in terms of the costs incurred (Christensen, 1997). In essence, by limiting this study to contracts that are 75%

complete the results of this thesis will be relatively conservative as cost performance beyond the 75% point has been shown to be fairly stable. Even if performance doesn't worsen it will, at most, remain unchanged.

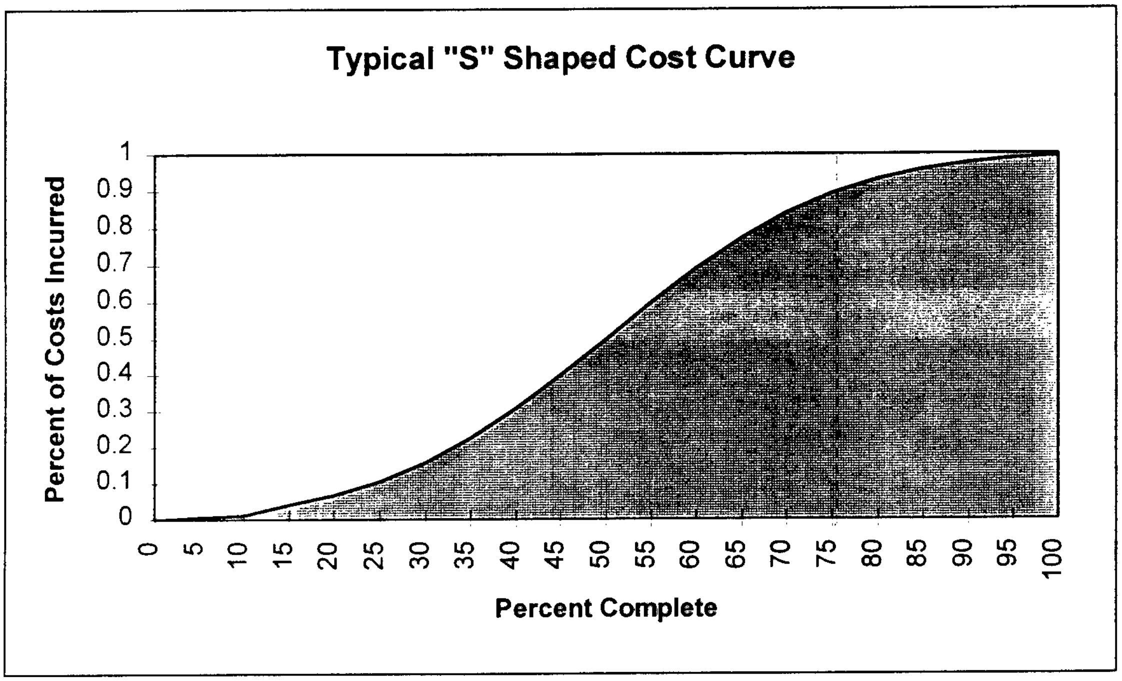

Figure 3. "S" Curve

__Sample Defined__. The contracts examined in this study represent only a portion of those contracts contained in the DAES database. First of all, while the DAES database does contain cost performance data reported on sensitive and highly classified contracts that type of data is not included in this study. Sensitive and highly classified contracts are managed under separate cost reporting requirements and are, therefore, not considered to be a part of the population of contracts examined in this study. Secondly, any contracts that may have been canceled prior to the 75 percent completion point would be excluded from the sample. Furthermore, one should understand that the definition relied upon for a "completed contract" reduces the usable database. Only 269 out of the 1,843 individual contracts contained in the database were retained for examination. Finally, any contracts not reporting BAC and ACWP figures or specifying program phase have been eliminated from the population as well. Thus, although some selection bias may be present in the study it is minimal. As such, the sample used in this research should represent the entire population of significant DOD contracts and subcontracts within all acquisition programs as defined in DODI 5000.2. One can assume then that any effects identified in this sample would be representative of the entire population.

Table 4 describes the population of contracts examined in this study. The table displays the number of contracts contributed by all services to the overall population in each of the categories; before and after Packard and development or production. Also shown by category are the average ACWP's, BAC's, and Final Overrun's and their associated standard errors. A complete listing of contracts is shown in the appendix.

Table 4. Population Of Contracts Described

	Before Packard			**After Packard**			**Total**
	development	production	subtotal	development	production	subtotal	
number	47	101	148	34	87	121	269
average ACWP	311.57	377.11	356.30	768.38	269.00	576.68	452.90
standard error	597.94	1276.40	1105.04	2010.85	426.10	1121.44	1115.47
average BAC	294.30	363.10	341.25	647.03	458.14	515.91	417.70
standard error	542.21	1231.90	1060.85	1661.21	389.53	935.46	1008.07
average FO	-17.28	-14.01	-15.05	-121.35	-35.80	-60.78	-35.20
standard error	59.35	53.43	55.20	499.44	84.22	274.17	189.28

-averages and standard errors reported in millions

Research Variable Defined

This study examines cost overruns on completed contracts, or the "final overrun," as opposed to the "current overrun" which is the adverse cost variance to date on a contract in progress. The final cost overrun is then measured as the difference between the budget for all the work on the contract, the BAC, and the actual cost of the work performed (ACWP) as of the time the CPR was submitted. If a variance, or a difference, exists between the ACWP and the BAC then the contractor either spent more or less money than what was planned. Either case is of concern if the variance is significant.

As defined in Chapter II the overrun at completion is calculated as the difference between the BAC and the EAC. This is the same formula as described above as the BCWP of a completed contract is the same as the BAC, and the ACWP of a completed contract equals, or rather replaces, the EAC. The ACWP reflects the total costs incurred and is not simply an estimate. For the purposes of this study, the final overrun, or cost variance, can then be calculated as shown in Equation 3. Thus, a negative final overrun figure will indicate the occurrence of an overrun; positive, an underrun.

$$\begin{matrix}\text{Final}\\\text{Overrun}\end{matrix} = \begin{matrix}\text{Final}\\\text{BAC}\end{matrix} - \text{ACWP} \qquad (3)$$

This final overrun (FV) measure can be misleading. Final overrun, calculated as shown above, fails to consider contract size (in terms of total dollar value) and inflation. Certainly one cannot reasonably compare a $1 million dollar overrun on a $100 million dollar contract with a $1 million dollar overrun on a $2 million dollar contract. In both cases the overrun is $1 million; however, that figure represents a one percent overrun in the first scenario compared to a 50 percent overrun in the second. Also, the effects of inflation over the years must be accounted for. By converting the final overrun figure to a final overrun percentage one can adjust the figure for size and inflation thus providing a relative measure of cost performance. The final overrun percentage (FO%) can be calculated as shown in Equation 4.

$$\textbf{FO\%} = \frac{Overrun_{Final}}{BAC_{Final}} \qquad \textbf{(4)}$$

The methodology used in this thesis uses the mean FO% of each population as the parameter of study. For the purposes of this study the mean FO% is calculated is shown in Equation 5.

$$\textbf{Mean FO\%} = \frac{\sum_{1}^{n} FO\%_i}{n} \qquad \textbf{(5)}$$

where i = the ith contract in the population and n = the total number of observations (contracts) in the population.

Statement of Hypotheses

The research questions and the hypotheses tested are listed below.

***Research Question #1*:** Is the mean final overrun percentage (FO%) for contracts completed before Dec.31,1991 different than the mean variance percentage afterwards? If the following hypothesis is true we can assume that the Packard recommendations were ineffective at reducing cost overruns. If the following hypothesis is rejected we can assume that cost performance changed (for the better or for the worse) as a result of the recommendations.

***Hypothesis 1*:**
H_o: mean FO% (FO%μ) $_{\text{before Dec 31, 1991}}$ = FO%μ $_{\text{afterwards}}$
H_a: FO%μ $_{\text{before Dec 31, 1991}}$ $\neq$ FO%μ $_{\text{afterwards}}$

***Research Question #2*:** Does the mean FO% for contracts completed before and after Dec.31,1991 differ between program phase? If the following hypothesis is true we can assume that the Packard recommendations were ineffective at reducing cost overruns in development or production contracts. If the following hypothesis is rejected we can assume that cost performance changed (for the better or for the worse) as a result of the recommendations.

***Hypothesis 2*:**
H_o: FO%$\mu_{\text{development/before}}$ = FO%$\mu_{\text{development/after}}$
H_a: FO%$\mu_{\text{development/before}}$ $\neq$ FO%$\mu_{\text{development/after}}$

Hypothesis 3:
H_o: FO%$\mu_{\text{production/before}}$ = FO%$\mu_{\text{production/after}}$
H_a: FO%$\mu_{\text{production/before}}$ $\neq$ FO%$\mu_{\text{production/after}}$

Method of Analysis

Each of the hypotheses, generated from the two research questions will be tested by statistical analysis using one or both of the models identified below. Research question #1 was analyzed in both phases. Research question # 2 was analyzed only in phase two. These are non-directional tests. Inferences about direction and magnitude of any effect will be made by descriptive analysis of the data.

Phase I Model

The first phase, shown in Table 5, tested for differences in the mean FO% between contracts completed before and after the treatment date (December 31, 1991).

Table 5. Phase I Model

Before Packard	After Packard
$\overline{FO\%}_{before} = \frac{\sum_{1}^{n} FO\%_i}{n}$	$\overline{FO\%}_{after} = \frac{\sum_{1}^{n} FO\%_j}{n}$
where i = the ith contract in the before treatment population and n = the total number of observations (contracts) in that population.	where j = the jth contract in the after treatment population and n = the total number of observations (contracts) in that population.

Phase 2 Model

The second phase tested for differences in the mean FO% between program phase (development or production) contracts completed before and after the treatment. As seen in Table 6 this phase is essentially testing vertically and included two tests.

Test 1: Development, Before vs After Packard
Test 2: Production, Before vs After Packard

Table 6. Phase II Model

	Development	Production
Before Packard	$\overline{FO\%}dev_{before} = \frac{\sum_{1}^{n} FO\%_k}{n}$ where k = the kth development contract in the before treatment population and n = the total number of observations (contracts) in that population.	$\overline{FO\%}prod_{before} = \frac{\sum_{1}^{n} FO\%_l}{n}$ where l = the lth production contract in the before treatment population and n = the total number of observations (contracts) in that population.
After Packard	$\overline{FO\%}dev_{after} = \frac{\sum_{1}^{n} FO\%_m}{n}$ where m = the mth development contract in the after treatment population and n = the total number of observations (contracts) in that population.	$\overline{FO\%}prod_{after} = \frac{\sum_{1}^{n} FO\%_p}{n}$ where p = the pth production contract in the after treatment population and n = the total number of observations (contracts) in that population.

Tests For Difference Between Population Means

The principal statistical analysis used in this study tests for a difference in the population means. Using the sample mean as an estimator of the population mean allows for inferences to be made about the differences between population parameters. Because the sample sizes are large more reliable inferences can be made with fewer assumptions about the sampled population (McClave & Benson, 1994:446). The t-test is a parametric test which can be used to detect a difference between the means of two populations--if such a difference exists (McClave & Benson, 1994:Ch 9). However, in order to use the t-statistic a number of assumptions must be satisfied: both sampled populations must be approximately normally distributed with equal population variances, and the random samples must be selected independently of each other. In order to analyze data from populations that do not satisfy these assumptions a nonparametric statistical method such as the Mann-Whitney test or the Kruskal-Wallis H-test must be used (Connover, 1980:229). These two tests are the nonparametric counterparts to the two sample t-test.

The Mann-Whitney test was designed to test two independent samples. The Kruskal-Wallis test is an extension of the Mann-Whitney test designed to tackle the problem of analyzing k independent samples, for $k \geq 2$ (Connover, 1992:229, McClave & Benson, 1994:Ch 17). The Kruskal-Wallis test uses the same information contained in the observations as does the Mann-Whitney test and studies have shown that for two samples the Kruskal-Wallis test is equivalent to the Mann-Whitney test (Connover, 1980:236, McClave & Benson, 1994:928).

The Mann-Whitney test "has been found to perform particularly well as a test for equal means, since it is especially sensitive to differences in location" (Gibbons, 1971:149). In fact, "when the populations are assumed to differ only in location, the Mann-Whitney test is directly comparable with Student's t-test for means" (Gibbons, 1971:149). Consequently, many statisticians consider the Mann-Whitney test the best nonparametric test for location (Gibbons, 1971:149). For these reasons this study will use the Mann-Whitney test as the nonparametric model of choice.

The Mann-Whitney test for a completely randomized design is a nonparametric model which can be used to compare two populations when the t-test is inappropriate for making the comparison (Connover, 1980:229, McClave & Benson, 1994:928). It tests the null hypothesis that the two populations are identical against the alternative that one of the populations tends to furnish greater observed values than the other. When the assumptions are appropriate, parametric tests are generally more powerful than their nonparametric equivalents, although nonparametric tests often compare quite well in performance (McClave & Benson, 1994, Ch 17; Connover, 1980:1-4). The parametric models test hypotheses regarding the group means. The nonparametric methods, on the other hand, test central value hypotheses based on measures other than the mean such, for example, the median (McClave & Benson, 1994:Ch 9 & Ch 17). When the assumptions are satisfied this study uses the more robust parametric method. When the assumptions are not satisfied the nonparametric method is used.

Data Preparation

As stated previously, this study limited the population of contracts examined to only completed contracts - all others were discarded from the study. These completed contracts were then sorted into either pre or post treatment based on the date of the last CPR submitted. They were then further categorized by program phase. A total of three tests were conducted in order to answer the research questions: one in phase I and two in phase 2. Tables 7 and 8 display the assumptions and hypotheses for both the parametric t-test and for the nonparametric Mann-Whitney test.

Table 7. Assumptions

t-test	Mann-Whitney test
1. All samples are random samples from their respective populations.	1. All samples are random samples from their respective populations.
2. All samples are independently selected from their respective populations.	2. All samples are independently selected from their respective populations.
3. Both sampled populations have relative frequency distributions that are approximately normal.	3. The 2 probability distributions from which the samples are drawn are continuous.
4. The population variances are equal.	

Table 8. Hypotheses

	t-test	Mann-Whitney test
H_o	$(\mu_1 - \mu_2) = 0$	The 2 sampled populations have identical probability distributions.
H_a	$(\mu_1 - \mu_2) \neq 0$	The probability distribution for population A is shifted to the left or to the right of that for B

Randomness. The assumption of a random sample applies to both models. "A sample from a finite population is a random sample if each of the possible samples was equally likely to be obtained" (Connover, 1980:62). As the populations being compared throughout this study are of manageable size the entire data set is used in every test. The use of the entire population, therefore, satisfies this assumption. Since samples don't have to be obtained the means by which the samples are obtained (randomness) is not a factor.

Independence. This assumption, like randomness, applies to both models. One can assume that the population of major weapons systems contracts reported under DODI 5000.2 contains contracts independent of each other. First of all, although all of these contracts are regulated by the same legislation, for example, the Federal Acquisition Regulation, or the FAR, and instructions such as DODI 5000.2, all of the contracts are DoD contracts. Any likeness caused by particular legislation or regulations would not violate the assumption of independence as these laws would affect cost performance equally across all DoD contracts. Secondly, the database used in this study contains cost information from 378 programs encompassing 1,843 individual contracts. These programs could possibly influence the cost performance of the multiple contracts managed under their umbrellas. However, although a large number of the contracts may be managed by the same program personnel and while it is not uncommon for a particular program to contain dozens of individual contracts, most cost management activities are performed by a multitude of individual contractors not by one particular program office. For these reasons the assumption of independence can be established. Readers should be aware that a violation of this assumption leads to a decrease in the confidence of any inferences made from the test results. Due to the exploratory nature of this research, a level of significance (α) of 10 percent is established. This means that the probability of making a type 1 error (rejecting the null hypothesis when it is in fact true) is 10 percent.

Model Selection. When the assumptions are appropriate, parametric tests are generally more powerful than their nonparametric equivalents. (McClave & Benson, 1994:Ch 17) Although nonparametric tests often compare quite well in performance the preference in this study is the use of the more powerful t-test. Therefore, the first test conducted on each population is one of normality. A number of tests, both graphical and non-graphical, are available for assessing normality (Stevens, 1992:251). One of the popular graphical procedures is to simply examine the histogram for each dependent variable in each group. "This does give some indication whether normality might be violated. However, with small or moderate sample size, it is difficult to tell whether the non-normality is real or apparent, because of considerable sampling error" (Stevens, 1992:253). For this reason the preference among researchers is the use of a non-graphical test.

The Shapiro-Wilk test for normality comes highly recommended over less rigorous tests such as the chi-square test for normality or the Kolmogorov-Smirnov test, and, overall, it is probably the most powerful non-graphical test in detecting departures from normality (D'Agostino & Stephens, 1986:406; Stevens, 1992:253). For these reasons, the Shapiro-Wilk test is used to test for normality in the population distributions. The test produces an approximate Shapiro-Wilk test statistic ranging from 0 to 1. A small value for the statistic (as determined by α and the sample size) indicates non-normality (Connover, 1980:363-366). The only assumption required for the Shapiro-Wilk test is that the sample is a random sample. The level of significance for the normality tests is also set at 10 percent.

If the population has a normal distribution the next step is to test for equal variance. If the population does not have a normal distribution the test for equal variance is not required, and the Mann-Whitney test is used. (see the decision tree in Figure 3.2) "The common statistical procedure for comparing population variances (σ_1^2 and σ_2^2) makes an inference about the ratio, (σ_1^2/σ_2^2), based on the ratio of sample variances, s_1^2/s_2^2" (McClave & Benson, 1994: 412). This ratio has an approximate F distribution. When the population variances are unequal the ratio F of the sample variances is expected to be either very large or very small (Connover, 1980:246-247; McClave & Benson, 1994:412). Two assumptions are required for the F test. The two sampled populations must be normally distributed, and the samples are randomly and independently selected from their respective populations. The level of significance, α, for these tests is also set at 10 percent . When these assumptions are satisfied and the two population variances are equivalent the sampling distribution of $F = s_1^2/s_2^2$ is the F distribution (McClave & Benson, 1994:412). These F distributions are tabulated and are then compared to the calculated F statistics. If the calculated F statistic is greater than the tabulated value then the null hypothesis of equal variances is rejected. If the populations to be compared have normal distributions and equal variances then the t-test is conducted. If the assumptions of normality and equal variance are not satisfied the Mann-Whitney test is used. The decision tree shown in Figure 4 displays the logic of the model selection used in this thesis.

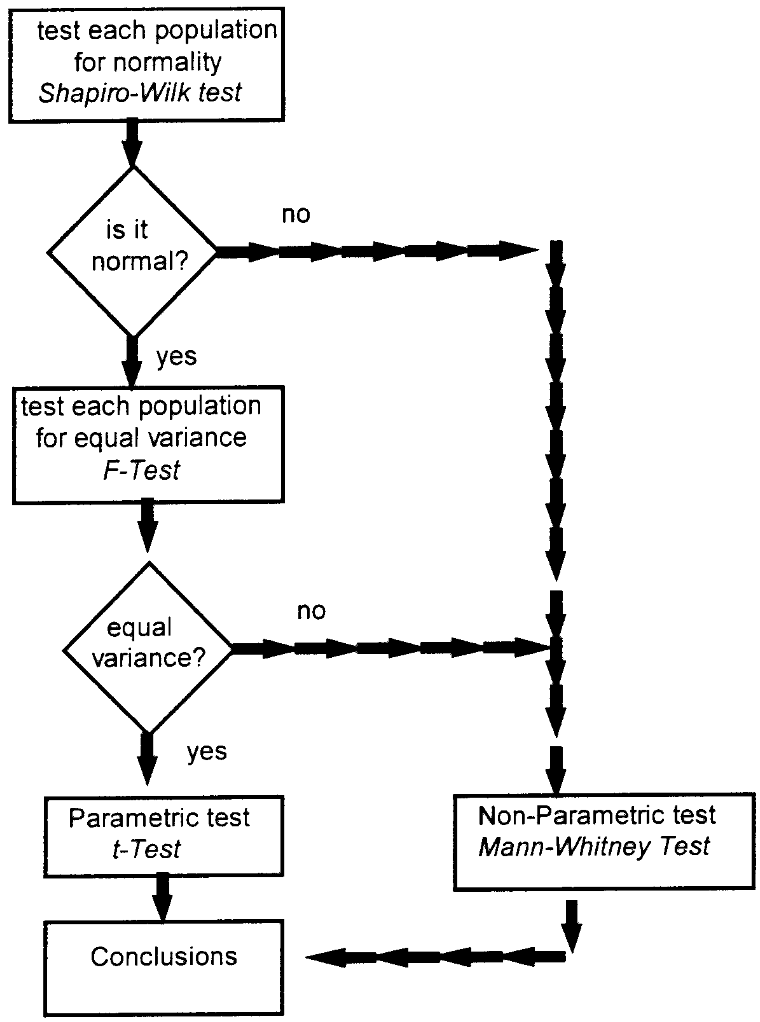

Figure 4. Decision Tree For Model Selection

<u>Robustness</u>

The tests identified above are set up as mathematical models which are based on the assumptions already discussed. As "all mathematical models are approximations to reality, violations of the assumptions are inevitable" (Stevens, 1992:237). The question to ask, then, is "how much can a given assumption be violated before it affects the error rate (α)?". The t and F tests are fairly robust with respect to the normality assumption, but only when the samples are large (Stevens, 1992:238). Robust means that the actual error rate (α) is very close to the nominal α (the level set by the experimenter). The F statistic is also robust against heterogeneous variances when group sizes are equal (Stevens, 1992:238-239).

The most important assumption, however, is that of independence. "It is by far the most important assumption for even a small violation of it produces a substantial effect on the level of significance" (Stevens, 1992:239). Recall that the assumption of independence is required for both the parametric t-test and the non-parametric Mann-Whitney model. The requirements for normality and homogeneous variance in the parametric model will be held to strict interpretations of the test results even though some researchers view them as fairly robust models with respect to normality and variance (Stevens, 1992:239). The rationale used here is that any violations simply lead to a further decrease in the confidence of inferences made from the test results. The decision tree displayed in Figure 4 displays the model selection process that will be followed in this thesis.

Summary

The DAES database provides the researcher with summary cost performance data on significant defense contracts and allows for the ready calculation of cost overruns or cost variances. The various data fields presented in the database also allow the researcher to categorize these contracts by factors such as completion date, program phase, and branch of service among others. This categorization allows the researcher to more thoroughly examine the possible effects of treatments, such as policy changes, on cost performance, and it supports the hypothesis testing required to answer the research questions of this thesis. Using parametric and nonparametric statistical methods we can determine whether or not differences exist between the mean final overrun percentages of the before and after groups. If the changes implemented as a result of the Packard Commission's recommendations were effective in reducing cost overruns a difference in the mean final overrun percentage should be noted between the population of contracts completed before and after the change. Specifically, the mean final overrun percentage should increase as a result of the treatment.

IV. Results

Statistical Results of the Hypothesis Tests

The chapter presents the results of the statistical tests conducted to answer the two research questions presented in Chapters I and III. The results are presented by phase, and an analytical summary for all tests are presented in Table 9 at the end of this chapter.

Data Description of the Phase I Model. The first phase tested for differences in the mean FO% between contracts completed before and after the treatment date (December 31, 1991). The null hypothesis states that the mean FO% before the treatment date is equal to the mean FO% afterwards while the alternate hypothesis states that the FO% before is different than that afterwards. Table 9 on page 74 displays the two populations of contracts examined in the first test. This test compared the population of contracts completed before the Packard recommendations with the population of contracts completed afterwards. Figures 5 and 6 show a graphical representation of the two populations in the form of two histograms. A smooth line representing a normal probability distribution is overlaid on both distributions allowing the reader to graphically compare the actual distributions with approximately normal distributions.

Test of Normality Results. The null hypothesis for the Shapiro-Wilk test states that the distribution is normal while the alternate hypothesis states that it is non-normal. The only assumption required for the test is that the sample is a random sample, and the level of significance (α) for the normality test was set at 10 percent. The Shapiro-Wilk test performed on the population of contracts completed before Packard produced a test statistic of .8464. The p-value associated with this test statistic was approximately zero indicating non-normality in the distribution. The Shapiro-Wilk test performed on the population of contracts completed after Packard produced a test statistic of .833. The p-value associated with this test statistic was also approximately zero indicating that this distribution was non-normal as well.

Both of the populations to be compared appear to have non-normal distributions at the 90 percent level of confidence. This is evident graphically as well. The problem of skewness and kurtosis in the two distributions, as shown in Figures 5 and 6, provides graphical support of the non-normality results obtained from the Shapiro-Wilk test. As such, the test for equal variance was not required, and the non-parametric Mann-Whitney test was selected to test the hypothesis.

Results. The Mann-Whitney model tests the null hypothesis which states that the two sampled populations have identical probability distributions against the alternate hypothesis which states that the probability distribution for population A (the population before Packard) is shifted to the right of that for population B (the population after Packard). The test performed on the two distributions produced a test statistic of 7941.0 which has an associated p-value of .0553347. As the level of significance for this test was established at 10 percent (α=.10) the results suggests that sufficient evidence exists to reject the null hypothesis at the 90 percent level of confidence. The two distributions may actually differ in location. In other words, the mean percentage overrun for contracts completed after the treatment appears to be statistically different than the mean percentage overrun for the earlier group. In fact, the distribution of the population of development contracts completed after Packard seems to be shifted to the left of the earlier population. Otherwise stated, the mean percentage overruns seems to have worsened after the policy went into effect.

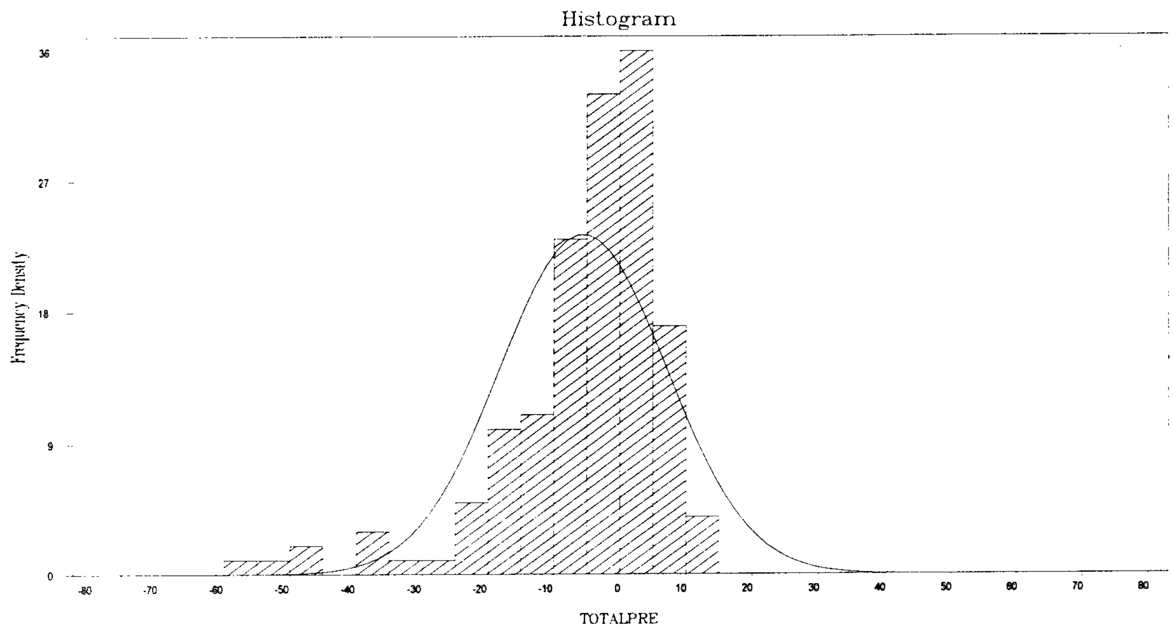

Figure 5. Histogram - Population of Contracts Before Packard

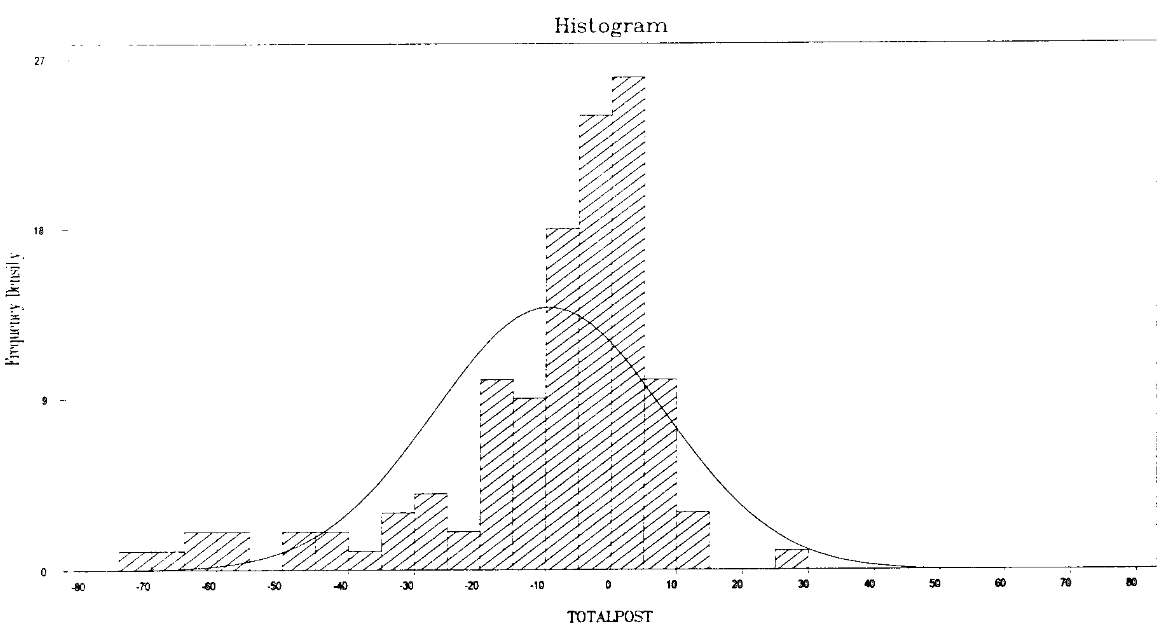

Figure 6. Histogram - Population of Contracts After Packard

Data Description of the Phase 2 Model. The second phase tested for differences in the mean FO% between program phase (development or production) contracts completed before and after the treatment date (December 31, 1991).and included two tests. The null hypothesis for the first test states that the mean FO% of development contracts completed before the treatment date is equal to the mean FO% of development contracts completed afterwards while the alternate hypothesis states that the FO% before is different than that afterwards. Table 9 displays the two populations of contracts examined in the first test. This test compared the population of development contracts completed before the Packard recommendations with the population of development contracts completed afterwards. Figures 7 and 8 show a graphical representation of the two populations in the form of two histograms. A smooth line representing a normal probability distribution is overlaid on both distributions allowing the reader to graphically compare the actual distributions with approximately normal distributions.

Test of Normality Results. The null hypothesis for the Shapiro-Wilk test states that the distribution is normal while the alternate hypothesis states that it is non-normal. The only assumption required for the test is that the sample is a random sample, and the level of significance (α) for the normality test was set at 10 percent. The Shapiro-Wilk test performed on the population of development contracts completed before Packard produced a test statistic of .8073. The p-value associated with this test statistic was approximately zero indicating non-normality in the distribution. The Shapiro-Wilk test performed on the population of contracts completed after Packard produced a test statistic of .8681. The p-value associated with this test statistic was .0005 indicating that this distribution was non-normal as well.

Both of the populations to be compared appear to have non-normal distributions at the 90 percent level of confidence. This is evident graphically as well. The problem of skewness and kurtosis in the two distributions, as shown in Figures 7 and 8, provides graphical support of the non-normality results obtained from the Shapiro-Wilk test. As such, the test for equal variance was not required, and the non-parametric Mann-Whitney test was selected to test the hypothesis.

Results. The Mann-Whitney model tests the null hypothesis which states that the two sampled populations have identical probability distributions against the alternate hypothesis which states that the probability distribution for population A (the population of development contracts completed before Packard) is shifted to the right of that for population B (the population of development contracts completed after Packard). The test performed on the two distributions produced a test statistic of 559.5 which has an associated p-value of .0153433. As the level of significance for this test was established at 10 percent (α=.10) the results suggest that sufficient evidence exists to reject the null hypothesis at the 90 percent level of confidence. The two distributions may differ in location. In fact, the distribution of the population of development contracts completed after Packard seems to be shifted to the left of the earlier population. Otherwise stated, the mean percentage overruns seems to have worsened after the policy went into effect.

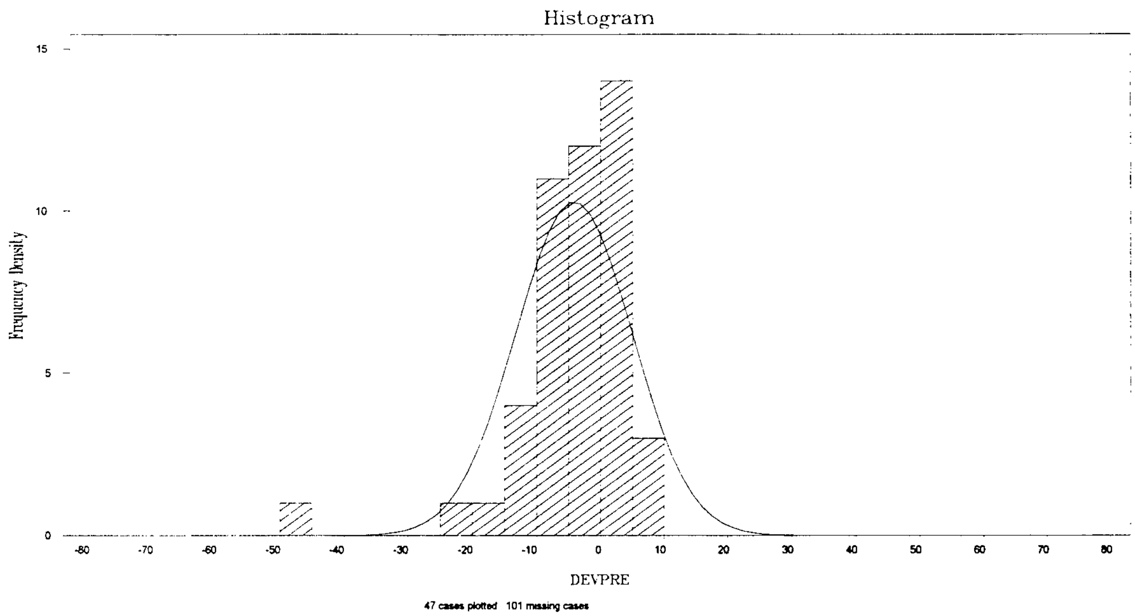

Figure 7. Histogram - Population of Development Contracts Before Packard

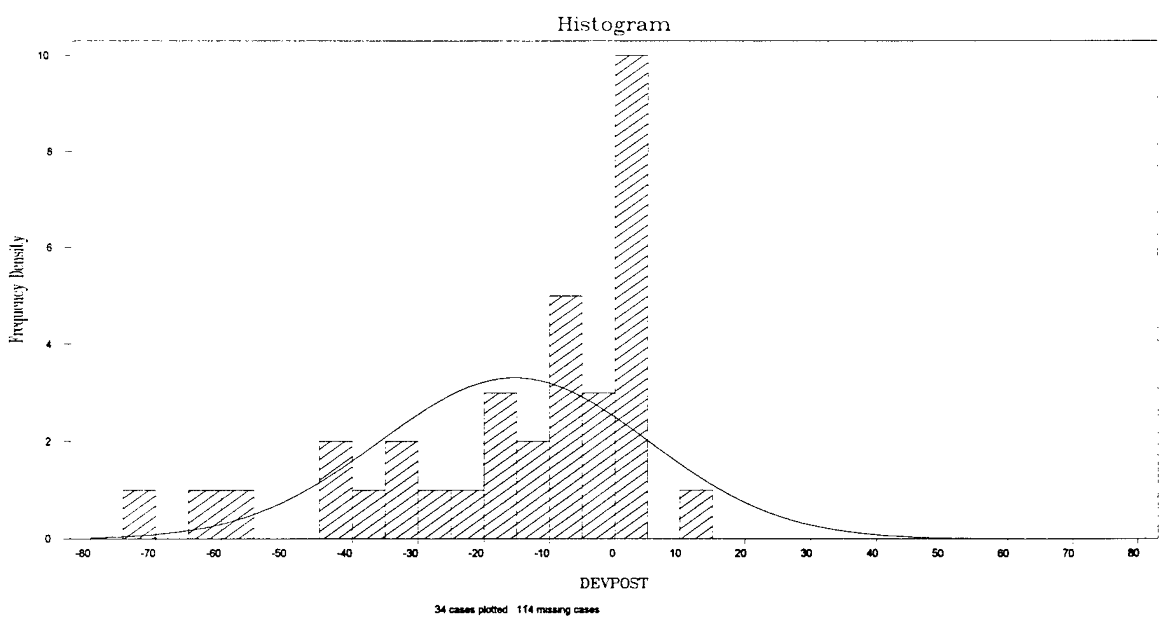

Figure 8. Histogram - Population of Development Contracts After Packard

Data Description of The Phase 2 -Test 2 Model. The null hypothesis for the second test states that the mean FO% of production contracts completed before the treatment date is equal to the mean FO% of production contracts completed afterwards while the alternate hypothesis states that the FO% before is different than that afterwards. Table 9 displays the two populations of contracts examined in the first test. This test compared the population of production contracts completed before the Packard recommendations with the population of production contracts completed afterwards. Figures 9 and 10 show a graphical representation of the two populations in the form of two histograms. A smooth line representing a normal probability distribution is overlaid on both distributions allowing the reader to graphically compare the actual distributions with approximately normal distributions.

Test of Normality Results. The null hypothesis for the Shapiro-Wilk test states that the distribution is normal while the alternate hypothesis states that it is non-normal. The only assumption required for the test is that the sample is a random sample, and the level of significance (α) for the normality test was set at 10 percent. The Shapiro-Wilk test performed on the population of production contracts completed before Packard produced a test statistic of .8659. The p-value associated with this test statistic was approximately zero indicating non-normality in the distribution. The Shapiro-Wilk test performed on the population of contracts completed after Packard produced a test statistic of .8268. The p-value associated with also approximately zero indicating that this distribution was non-normal as well.

Both of the populations to be compared appear to have non-normal distributions at the 90 percent level of confidence. This is evident graphically as well. The problem of skewness and kurtosis in the two distributions, as shown in Figures 9 and 10, provides graphical support of the non-normality results obtained from the Shapiro-Wilk test. As such, the test for equal variance was not required, and the non-parametric Mann-Whitney test was selected to test the hypothesis.

Results. The Mann-Whitney model tests the null hypothesis which states that he two sampled populations have identical probability distributions against the alternate hypothesis which states that the probability distribution for population A (the population of production contracts completed before Packard) is shifted to the right of that for population B (the population of production contracts completed after Packard). The test performed on the two distributions produced a test statistic of 4191.5 which has an associated p-value of .294025. As the level of significance for this test was established at 10 percent (α=.10) the results suggest that insufficient evidence exists to reject the null hypothesis at the 90 percent level of confidence. The two distributions may not differ in location. In other words, the mean percentage overrun for contracts completed after the treatment doesn't appear to be statistically different than the mean percentage overrun for the earlier group. No effect was noted.

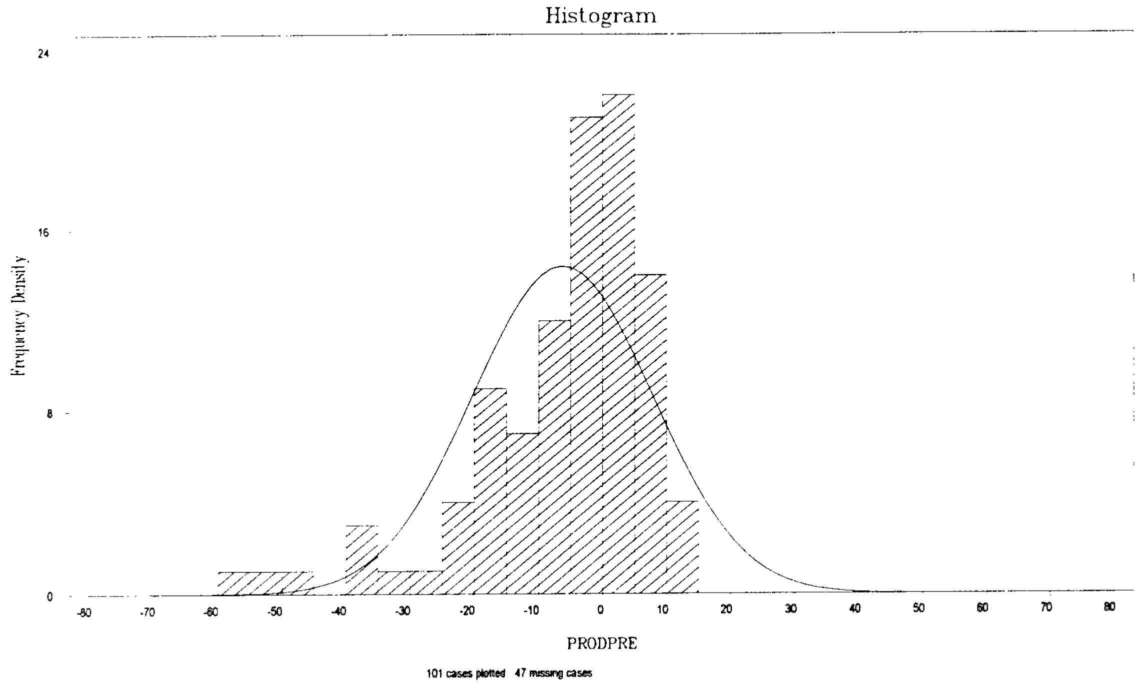

Figure 9. Histogram - Population of Production Contracts Before Packard

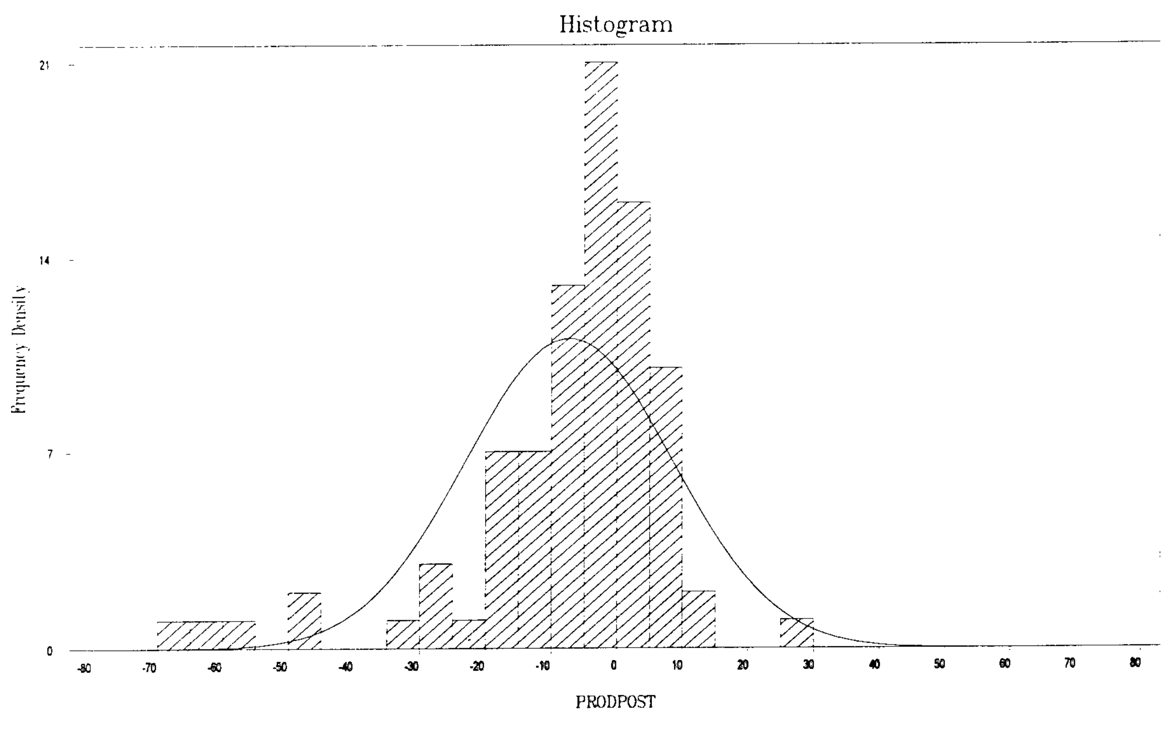

Figure 10. Histogram - Population of Production Contracts After Packard

Table 9. Statistical Analysis Summary

Total population of contracts :

sample 1:	Total Pre	148 values	ranging from	-57.8947	to	12.3779
sample 2:	Total Post	121 values	ranging from	-71.0526	to	25
	sample 1			sample 2		
Shapiro-Wilk	.846402		Shapiro-Wilk	.83301		
p- value	0		p- value	0		
mean FO%	-5.56		mean FO%	-9.58		
standard error	12.65		standard error	17.42		
Mann-Whitney test statistic	7941	p-value:	0.0553347			

Total population of development contracts

sample 1:	Dev Pre	47 values	ranging from	-48.4848	to	9.52381
sample 2:	Dev Post	34 values	ranging from	-71.0526	to	10.5263
	sample 1			sample 2		
Shapiro-Wilk	.807295		Shapiro-Wilk	.868057		
p- value	0		p- value	.0005		
mean FO%	-4.14		mean FO%	-15.29		
standard error	9.11		standard error	20.46		
Mann-Whitney test statistic	569	p-value:	0.0140119			

Total population of production contracts

sample 1:	Prod Pre	101 values	ranging from	-57.8947	to	12.3779
sample 2:	Prod Post	87 values	ranging from	-68.75	to	25
	sample 1			sample 2		
Shapiro-Wilk	.865886		Shapiro-Wilk	.826806		
p- value	0		p- value	0		
mean FO%	-6.22		mean FO%	-7.24		
standard error	13.99		standard error	15.66		
Mann-Whitney test statistic	4191.5	p-value:	0.294025			

Summary

The results of the three hypothesis tests are summarized in Table 9. The non-parametric Mann-Whitney test was used in all of the tests as the results of the Shapiro-Wilk test indicated that all six of the samples appeared to have non-normal distributions. A graphical analysis of the distributions supported the non-graphical test results as skewness and kurtosis was evident in all six samples. Variance tests were not required as a basis for the Mann-Whitney model.

The results of the first hypothesis test indicated that the mean final overrun percentage (FO%) for contracts completed after the Packard Commission's recommendations was significantly different than that for those completed prior to the treatment at the .10 level of significance. The p-value for the Mann-Whitney test statistic was .055 which is a significant effect. There was sufficient evidence to indicate that the final overrun percentage for contracts completed after the treatment was statistically different than the FO% of the earlier population. The test results suggest that cost performance actually worsened after the treatment went into effect. In fact, the mean percentage overrun for the latter group (-9.58) was nearly double that of the earlier group (-.56), a difference of 4.02. A similar, but more dramatic, result was found in the second test. A significant difference was found in the second hypothesis test regarding development contracts. The results of that test were stronger as the p-value of the Mann-Whitney test statistic was .01, considerably less than the .10 level set for the experiment. Those results suggested that the mean FO% for development contracts had also changed in the post-treatment group. In fact, cost performance was considerably poorer as the mean FO% more than tripled (-4.14 to -15.29) after the changes went into effect, a difference of 11.15. Lastly, the results of the third test suggested that the there was no significant difference in the FO% for production contracts completed before and after the treatment.

Figures 11,12, and 13 graphically illustrate these results using overlaid density traces of each of the populations. A density trace is a plot of the shape or distribution of a data set, especially the variations in density over the range of the data. The dashed lines represent the population distributions of the Final Overrun percentages prior to the change while the solid lines represent the latter FO% distributions. The top graph, Figure 11, compares the distributions of the total group of contracts before and after the change. The post group appears to have shifted to the left slightly providing further support to the conclusions drawn above. Recall that a leftward shift indicates poorer cost performance as a negative overrun figure signifies a cost overrun. The middle graph, Figure 12, illustrates the second test: the comparison of development contracts before and after the change. A more pronounced leftward shift can be noted in the post group which, again, supports the conclusions drawn above. Finally, the bottom graph, Figure 13, displays the comparison of the distribution of production contracts before and after the change. As concluded above, it appears no significant change has occurred. Table 10 on page 79 summarizes the final results of the three hypothesis tests.

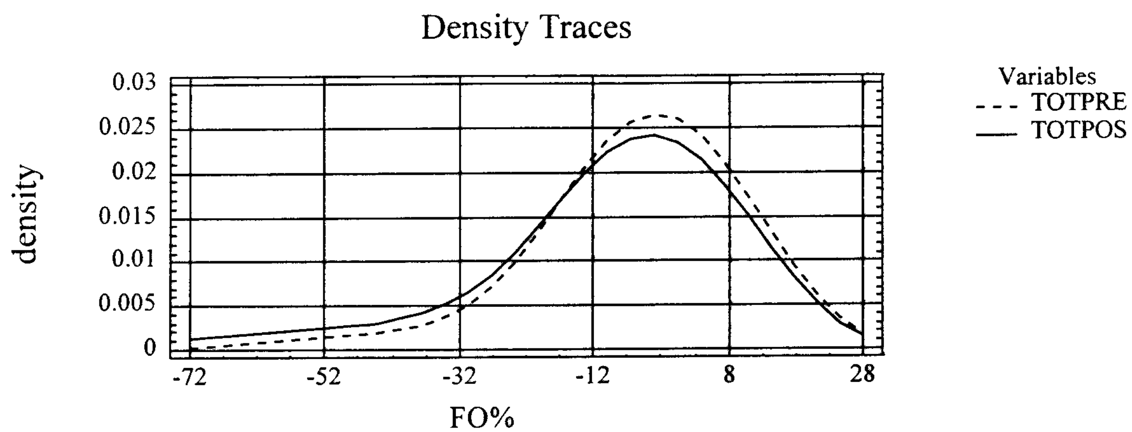

Figure 11. Overlaid Density Trace: Total Contracts

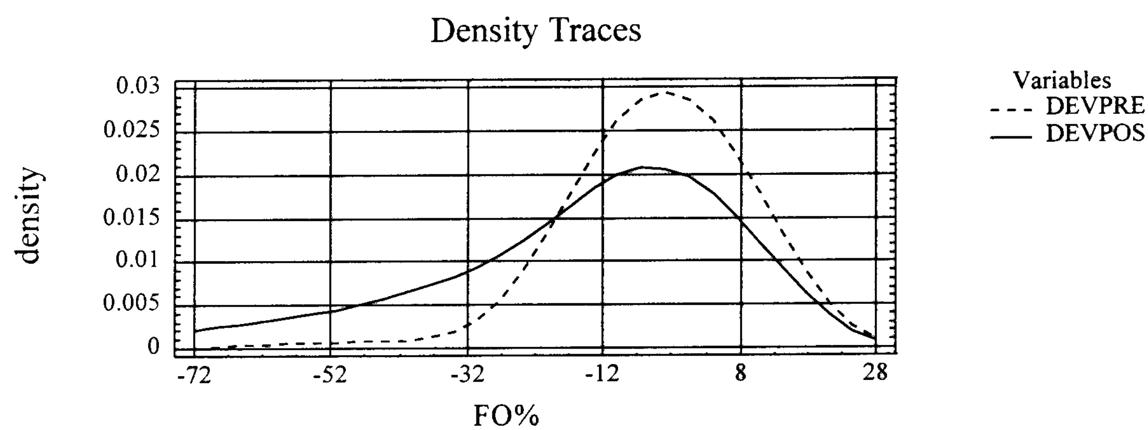

Figure 12. Overlaid Density Trace: Development Contracts

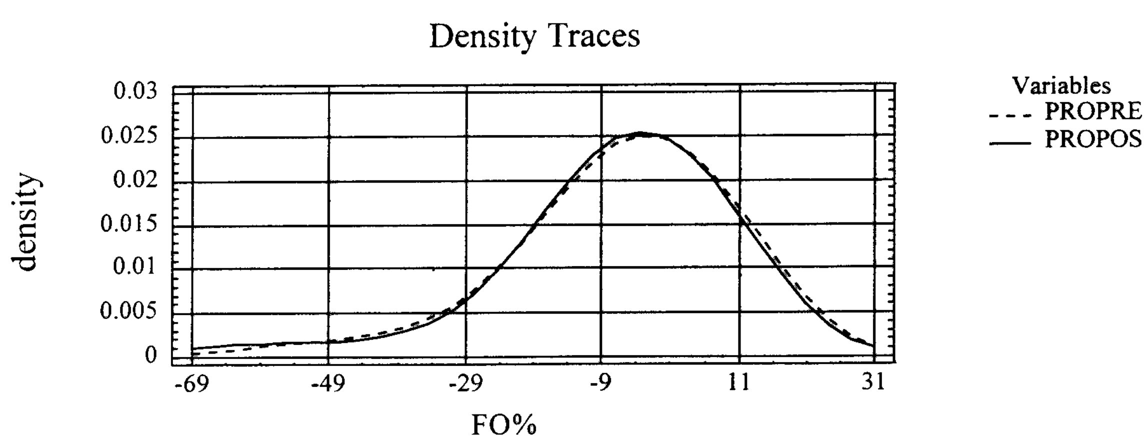

Figure 13. Overlaid Density Trace: Production Contracts

Table 10. Summary of Hypothesis Tests

Hypothesis	Results & Support
H1: mean FO% (FO%μ) $_{\text{before Dec 31, 1991}}$ = FO%μ $_{\text{afterwards}}$	reject p=.055 for Mann-Whitney test
H2: $FO\%\mu_{development/before} = FO\%\mu_{development/after}$	reject p=.014 for Mann-Whitney test
H3: $FO\%\mu_{production/before} = FO\%\mu_{production/after}$	do not reject p=.294 for Mann-Whitney test

This concludes the presentation of the results of the hypothesis tests proposed in chapter three. The next and final chapter draws conclusions from these statistical tests and further discusses the significance of the findings to the Department of Defense. Additionally, recommendations for further research are made.

V. Discussion

Overview

This chapter reviews the results of the analysis presented in Chapter IV and discusses the findings of this research effort as they apply to the Department of Defense. Additionally, potential limitations of this study are discussed and recommendations are made for further research.

Review of the Hypotheses

The hypotheses proposed in Chapter I are restated below:

1. Given a sample of completed contracts (the DAES database), the final overrun percentage for contracts completed after Dec. 31, 1991 is the same as the percent overrun of contracts completed before that date.

2. Given a sample of completed development contracts (the DAES database), the final overrun percentage for contracts completed after Dec. 31, 1991 is the same as the percent overrun of contracts completed before that date.

3. Given a sample of completed production contracts (the DAES database), the final overrun percentage for contracts completed after Dec. 31, 1991 is the same as the percent overrun of contracts completed before that date.

These hypotheses were tested using a sample of 269 contracts extracted from the DAES database and which were completed between January 1, 1988 and December 31, 1995. This eight year period provided for approximately four years of pre and post treatment data, and the length of time should have mitigated any potential bias due to factors such as fluctuations in the defense business cycle. The testing was conducted in order to test the effectiveness of the Packard Commission's recommendations on reducing cost overruns in DoD acquisition programs.

The principal statistical analysis used in this study tested the three hypothesis for differences in their population means as this would allow for inferences to be made about the differences between their population parameters. However, prior to conducting the principal test all of the sub-samples were individually tested for normality and for homogeneity of variance in their distributions. The results of these tests determined whether the parametric t-test or the nonparametric Man-Whitney test would be used as the determinant model. All of the sub-samples in this study appeared to have non-normal distributions; therefore, the three hypotheses were tested using the nonparametric Mann-Whitney test at a 90 percent level of confidence.

Conclusions

The first two hypotheses were rejected at the 90 percent level of confidence. The results of the first two tests indicated that the mean final overrun percentage (FO%) for all contracts and for development contracts completed after Dec. 31, 1991 was different than that for those completed prior to the treatment. Mean percentage overruns were actually lower after the policy went into effect indicating that cost performance had, in fact, worsened. Recall that a negative percentage overrun indicates a cost overrun. The third hypothesis was held to be true at the 95 percent level of confidence. The mean percentage overrun for production contracts didn't appear to change after the treatment. The data also suggests that the more significant change evident between the distributions of development contracts may account for the effect noted between the distributions of total contracts.

Overall, the testing suggests that the Commission's recommendations may have had a negative effect towards reducing cost overruns in major DoD acquisition programs. It appears that cost performance actually worsened after the treatment; in fact, the mean percentage overrun for total contracts nearly doubled after the change. The most dramatic effect, however, was noted in the population of development contracts. The mean percentage overrun for development contracts more than tripled following the change in policy.

Discussion of Findings

The results of these tests lie counter to the propositions and the two concerns introduced in the Chapter II summary. Based on the information presented in the literature review it was proposed that the recommendations would have little to no effect on reducing cost overruns. Specifically, it was proposed that cost overruns for contracts completed before and after the change would essentially be the same. Furthermore, it was proposed that the Commission's recommendations would affect contracts differently based on whether the contract was for development or production. In addition to these proposals two major concerns were forwarded in that summary. First of all, it was noted in chapter two that little progress has been made over the years in reducing the problem of cost growth. In fact, studies have indicated that cost growth has fluctuated around 20 to 40 percent since the mid 1960's and little improvement has occurred over time. As the Packard recommendations are similar to prior reform efforts which were ineffective why should the DoD realistically expect improvements in cost performance? Secondly, studies have shown that the minor problems of poor management actually account for only a relatively small portion of the cost growth. As such, even if the recommendations were effective a change may not be indicated because of the insignificance of the problem. However, the results of this thesis suggest that the recommendations may have had a significant effect on cost overruns, albeit, in the wrong direction. Not only did the Commission's recommendations appear to have inaccurately targeted some of the possible factors leading to the cost overrun problem but it's possible they may have been a factor leading to the poorer cost performance. Another possible explanation may be that while the policy didn't directly cause poorer cost performance it may have created an environment, simply by it's ineffectiveness, in which other causal factors may have been allowed to operate.

The cost performance problem seems to be the most profound in development contracts. Assuming that other extraneous causal factors have been controlled for it's possible that the Packard Commission's recommendations may have actually led to or caused poorer cost performance. Why, then, was an effect noted in development contracts but not in production contracts? The percentage cost overruns for development contracts more than tripled while no significant difference occurred with production contracts. As discussed in Chapter II the major provisions of the policy seem to apply to both development and production contracts with the exception of the requirement for increased testing and prototyping. It is possible that this recommendation may account for the dramatic change in development contract cost performance. It's reasonable to believe that the recommendation would impact development contracts significantly more than production contracts.

Unfortunately, some questions remain unanswered. Had the policy focused on factors such as planning difficulties, poor estimating, or the problems associated with competitive bidding perhaps significant reductions may have been achieved. At minimum, perhaps this type of approach may have controlled the overrun problem and prevented the escalation. The factors mentioned above are the those factors categorized as estimation errors in Chapter II. A number of possible factors have been identified as affecting cost growth. Independently these factors may lead to poor cost performance, but usually one or more (or a combination of many) are the real causes (Scott, 1983:38) Future policies may have more success if estimation errors are targeted or if, perhaps, a combination of estimation errors and mismanagement factors are targeted.

The results also support the proposition discussed in chapter three which stated that the policy changes would probably have a greater impact on contracts in the development phases than those in the production phases. As systems progress from the development to production phases the performance, schedule, and cost parameters become more predictable and less variable as the risks and uncertainties decrease over time. Program management is more effective as risks and uncertainties are reduced over time; therefore, one would expect the larger portion of cost overruns caused my management inefficiencies to occur in the development phases. Consequently, a more pronounced effect was noted in the development phase whereas no effect appeared to have occurred in the production phases.

This study raises some concerns regarding the appropriateness of current acquisition reform policies. Presently, the DoD is admittedly operating in an era of acquisition reform. The passing of the Federal Acquisition Streamlining Act (FASA) in 1994 and the Federal Acquisition Improvement Act (nicknamed FASA II) in 1995 marked the first major rewrites of acquisition policy since the Packard Commission's recommendations. A review of these acts indicates striking similarities between their major provisions and those of earlier reform efforts including the Packard Commission study. Themes such as streamlining, decentralization of authority, empowerment, and organizational culture change simply re-emerge in a newly packaged policy. Once again, it appears that the DoD is targeting alleged management inefficiencies as it's principle problem leading to procurement inefficiency. As these current provisions are so similar to prior reform efforts which were ineffective the DoD should not realistically expect improvements in cost performance.

Limitations

The data suggest that the recommendations forwarded by the Packard Commission may have been ineffective in reducing cost overruns at the 95 percent level of confidence; infact, the policy changes may have actually led to or fostered poorer cost performance. However, a number of limitations must be addressed regarding these conclusions.

Study Design. This study attempts to demonstrate a causal relationship between the policy changes (the recommendations made by the Commission) and cost overruns. "The essential element of causation is that A "produces" or A "forces" B to occur" (Cooper & Emory, 1995:123). However, one can never empirically demonstrate with certainty that some variable A causes some variable B to occur. At best one can structure a study and gather supportive evidence in such a way that increases the probability that A causes B. While this study can demonstrate that the time order of events moves in the hypothesized direction one of the major problems with it's design is that it was merely impossible to eliminate other possible causes.

This study is designed as an ex post facto design particularly because it was the only feasible approach. However, ex post facto designs are particularly weak at establishing or demonstrating causality (Cooper & Emory, 1995:129-131). Since archival data is used one cannot manipulate the variables nor assign subjects to treatment and control groups. As a result, multiple factors may be the cause of the reduction in cost overruns rather than the policy change itself. Furthermore, this study used a one-group pretest-posttest design which is considered a weak design for demonstrating causality as it fails to adequately control threats to internal validity. The results must be interpreted carefully in order to avoid post hoc fallacy.

Threats to External Validity. The process by which the contracts were selected may threaten external validity and bias the results. The contracts examined in this study represent only a portion of those contracts contained in the DAES database. First of all, while the DAES database does contain cost performance data reported on sensitive and highly classified contracts that type of data is not included in this study. Secondly, any contracts that may have been canceled prior to the 75 percent completion point would be excluded from the sample. Furthermore, one should understand that the definition relied upon for a "completed contract" reduces the usable database. Only 269 out of the 1,843 individual contracts contained in the database were retained for examination. Finally, any contracts not reporting BAC and ACWP figures or specifying program phase have been eliminated from the population as well. Thus, some selection bias is present in the study. As such, the sample used in this research does not represent the entire population of significant DOD contracts and subcontracts within all acquisition programs as defined in DODI 5000.2. One can not assume then that any effects identified in this sample would be representative of the entire population.

Threats to Internal Validity. Several threats to internal validity weaken the establishment of a causal relationship between the policy changes and the reduction in cost overruns. First of all, a history effect may be present. Certain events may have occurred over the eight year time period in which the contracts were managed that may confuse the relationship being studied. The contracts used in this study may have been effected by political, cultural-social, or technological changes. Secondly, one can reasonably assume that a maturation effect would be present. It's reasonable to believe that changes may have occurred within the contract that are a function of the passage of time, learning, and maturing and are not specific to any particular event. Finally, an instrumentation effect may be present. "This is a threat to internal validity that results from changes between observations, in measuring instrument or observer" (Cooper & Emory, 1995:358). This study examined the cost performance of 269 contracts as reported by program managers in the DAES database through cost performance reports. The integrity or reliability of the reported data can be assumed under EVMS reporting requirements, but it cannot be controlled for. It's important to note that an ex post facto/one-group pretest-posttest design such as the one used in this study is considered a weak design for controlling these threats to internal validity (Cooper & Emory, 1995:361).

Summary

This study showed that the recommendations made by the Packard Commission may have been ineffective in reducing cost overruns in major DoD acquisition programs and may have actually led to or fostered poorer cost performance. The data also suggests that the recommendations may have led to or fostered higher cost overruns in the riskier development phases as opposed to production phases.

Recommendations for Further Research

It is recommended that future research investigate other possible causes of the dramatic change in cost performance after December 31, 1991. Perhaps other significant factors not accounted for in this thesis may have been responsible for the changes noted. It is also recommended that future research include investigation of more recent policy changes and their resultant impact on contract cost performance. The Federal Acquisition Streamlining Act (FASA) of 1994 and the Federal Acquisition Improvement Act (nicknamed FASA II) of 1995 are considered the first major rewrites of government procurement regulations in a decade. Investigation into the tenets of these policies and their similarities and differences to prior reform efforts may yield insight as to the appropriateness of the current path of acquisition reform policies. This investigation may also provide an evaluation of the potential of these current policies to reduce or control cost overruns in DoD acquisition programs.

Furthermore, it is recommended that future research investigate the effects that the Integrated Baseline Review (IBR) policy may be having on reducing cost overruns. This 1994 policy is a major variance analysis policy which focuses more on areas such as planning difficulties and estimation errors as opposed to mismanagement. There is some early indication that since IBR's inception in 1994 the overall performance in terms of cost and schedule performance has improved for a number of programs (Christensen, 1997). It may take two or three more years before sufficient data becomes available to test for possible effects, but the information presented in this thesis suggests that the IBR policy may have more success at reducing cost overruns than the Packard Commission's recommendations as the policy seems to target those factors accounting for the relatively larger portion of cost growth. Finally, it is recommended that future research replicate this study using the cost growth model. A comparison of the two models may provide policy makers with a broader interpretation of policy effectiveness.

Appendix: Data Table For Contracts Used In This Study

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
4/25/88	Navy	P	34	33.00	-1	-3.030	89.189
5/25/88	Navy	P	657	725.00	68	9.379	90.852
8/25/88	Army	P	117	76.00	-41	-53.947	97.436
8/25/88	Army	P	58	49.00	-9	-18.367	90.741
10/25/88	Navy	P	217	204.00	-13	-6.373	88.696
12/25/88	Air Force	D	22	20.00	-2	-10.000	90.909
3/25/89	Navy	D	101	99.00	-2	-2.020	76.744
5/25/89	Air Force	D	114	123.00	9	7.317	97.619
5/25/89	Navy	P	30	19.00	-11	-57.895	90.476
6/25/89	Air Force	D	41	43.00	2	4.651	95.556
6/25/89	Air Force	D	31	32.00	1	3.125	94.118
6/25/89	Air Force	D	218	220.00	2	0.909	93.220
6/25/89	Air Force	D	19	21.00	2	9.524	80.769
6/25/89	Air Force	D	43	45.00	2	4.444	78.947
6/25/89	Air Force	P	43	38.00	-5	-13.158	102.703
6/25/89	Air Force	P	75	64.00	-11	-17.188	100.000
6/25/89	Air Force	P	97	96.00	-1	-1.042	98.969
6/25/89	Air Force	P	72	69.00	-3	-4.348	97.183
6/25/89	Air Force	P	95	91.00	-4	-4.396	96.809
6/25/89	Air Force	P	82	90.00	8	8.889	95.745
6/25/89	Air Force	P	40	44.00	4	9.091	95.652
6/25/89	Air Force	P	76	75.00	-1	-1.333	94.937
6/25/89	Air Force	P	163	166.00	3	1.807	94.318
6/25/89	Air Force	P	62	66.00	4	6.061	92.958
6/25/89	Air Force	P	320	275.00	-45	-16.364	92.905
6/25/89	Air Force	P	62	60.00	-2	-3.333	92.308
6/25/89	Air Force	P	116	120.00	4	3.333	91.603
6/25/89	Air Force	P	148	130.00	-18	-13.846	90.909
6/25/89	Army	P	750	792.00	42	5.303	94.511
6/25/89	Army	P	667	709.00	42	5.924	92.923
6/25/89	Navy	D	42	42.00	0	0.000	100.000
6/25/89	Navy	D	87	82.00	-5	-6.098	93.182
6/25/89	Navy	D	843	844.00	1	0.118	92.544
7/25/89	Air Force	P	70	77.00	7	9.091	106.944
7/25/89	Air Force	P	358	331.00	-27	-8.157	99.399
7/25/89	Air Force	P	135	130.00	-5	-3.846	97.744
7/25/89	Air Force	P	1128	1073.00	-55	-5.126	95.293
7/25/89	Air Force	P	58	54.00	-4	-7.407	94.737
7/25/89	Air Force	P	51	50.00	-1	-2.000	89.286
7/25/89	Army	P	184	193.00	9	4.663	95.545
7/25/89	Navy	D	161	133.00	-28	-21.053	97.794
7/25/89	Navy	D	139	137.00	-2	-1.460	93.836
7/25/89	Navy	D	139	137.00	-2	-1.460	93.836

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
7/25/89	Navy	D	954	907.00	-47	-5.182	92.551
7/25/89	Navy	D	954	907.00	-47	-5.182	92.551
7/25/89	Navy	D	51	47.00	-4	-8.511	87.037
7/25/89	Navy	P	144	148.00	4	2.703	97.368
7/25/89	Navy	P	698	607.00	-91	-14.992	95.141
7/25/89	Navy	P	114	115.00	1	0.870	93.496
7/25/89	Navy	P	130	126.00	-4	-3.175	93.333
8/25/89	Air Force	P	12687	12228.00	-459	-3.754	96.072
8/25/89	Air Force	P	592	595.00	3	0.504	93.260
8/25/89	Army	D	12	13.00	1	7.692	86.667
8/25/89	Navy	D	42	40.00	-2	-5.000	97.561
8/25/89	Navy	P	353	362.00	9	2.486	101.685
8/25/89	Navy	P	353	362.00	9	2.486	101.685
8/25/89	Navy	P	247	247.00	0	0.000	100.407
8/25/89	Navy	P	239	216.00	-23	-10.648	94.737
8/25/89	Navy	P	54	48.00	-6	-12.500	94.118
8/25/89	Navy	P	269	307.00	38	12.378	90.828
9/25/89	Air Force	P	150	153.00	3	1.961	91.617
9/25/89	Air Force	P	86	92.00	6	6.522	91.089
9/25/89	Army	D	96	98.00	2	2.041	98.990
9/25/89	Navy	D	367	366.00	-1	-0.273	94.574
9/25/89	Navy	P	72	76.00	4	5.263	105.556
9/25/89	Navy	P	36	24.00	-12	-50.000	100.000
9/25/89	Navy	P	34	34.00	0	0.000	100.000
9/25/89	Navy	P	870	790.00	-80	-10.127	97.411
10/25/89	Air Force	P	69	66.00	-3	-4.545	95.652
10/25/89	Navy	P	88	81.00	-7	-8.642	96.429
10/25/89	Navy	P	48	40.00	-8	-20.000	93.023
11/25/89	Air Force	D	596	608.00	12	1.974	96.970
11/25/89	Air Force	P	410	415.00	5	1.205	97.190
11/25/89	Army	D	142	121.00	-21	-17.355	98.374
11/25/89	Army	P	21	23.00	2	8.696	76.667
12/25/89	Army	P	55	60.00	5	8.333	89.552
12/25/89	Navy	D	316	290.00	-26	-8.966	97.315
12/25/89	Navy	P	113	105.00	-8	-7.619	92.920
2/25/90	Army	D	62	62.00	0	0.000	96.875
2/25/90	Navy	P	52	50.00	-2	-4.000	102.041
3/25/90	Air Force	P	73	81.00	8	9.877	95.294
3/25/90	Air Force	P	212	213.00	1	0.469	93.421
3/25/90	Air Force	P	1084	1084.00	0	0.000	80.296
3/25/90	Navy	P	54	54.00	0	0.000	98.182
4/25/90	Air Force	D	870	780.00	-90	-11.538	94.775
4/25/90	Air Force	P	409	324.00	-85	-26.235	105.537
4/25/90	Air Force	P	1145	1083.00	-62	-5.725	93.041
4/25/90	Air Force	P	152	148.00	-4	-2.703	90.798

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
4/25/90	Navy	D	243	227.00	-16	-7.048	93.802
4/25/90	Navy	P	290	265.00	-25	-9.434	92.982
6/25/90	Air Force	P	96	109.00	13	11.927	100.000
6/25/90	Air Force	P	84	91.00	7	7.692	100.000
6/25/90	Air Force	P	156	131.00	-25	-19.084	97.761
6/25/90	Air Force	P	146	121.00	-25	-20.661	96.032
6/25/90	Navy	D	157	159.00	2	1.258	108.904
6/25/90	Navy	P	171	168.00	-3	-1.786	104.348
7/16/90	Air Force	P	33	36.00	3	8.333	97.297
8/25/90	Navy	D	194	188.00	-6	-3.191	105.028
9/25/90	Air Force	D	67	66.00	-1	-1.515	98.507
9/25/90	Air Force	P	218	188.00	-30	-15.957	92.157
9/25/90	Navy	P	1631	1716.00	85	4.953	95.386
10/25/90	Air Force	D	41	36.00	-5	-13.889	92.308
10/25/90	Air Force	P	36	40.00	4	10.000	90.909
10/25/90	Navy	D	68	69.00	1	1.449	95.833
10/25/90	Navy	P	980	881.00	-99	-11.237	106.017
10/25/90	Navy	P	63	63.00	0	0.000	105.000
10/25/90	Navy	P	45	46.00	1	2.174	92.000
10/25/90	Navy	P	46	38.00	-8	-21.053	88.372
11/25/90	Army	D	42	39.00	-3	-7.692	100.000
11/25/90	Army	D	49	33.00	-16	-48.485	91.667
11/25/90	Navy	P	130	94.00	-36	-38.298	100.000
12/25/90	Air Force	D	160	156.00	-4	-2.564	200.000
12/25/90	Navy	D	3910	3513.00	-397	-11.301	101.123
12/25/90	Navy	D	684	661.00	-23	-3.480	100.609
12/25/90	Navy	P	1389	1293.00	-96	-7.425	96.927
12/25/90	Navy	P	336	331.00	-5	-1.511	89.459
2/25/91	Army	D	182	165.00	-17	-10.303	100.000
2/25/91	Navy	D	703	662.00	-41	-6.193	99.399
3/25/91	Air Force	P	183	154.00	-29	-18.831	98.089
3/25/91	Air Force	P	415	432.00	17	3.935	92.111
3/25/91	Navy	P	169	162.00	-7	-4.321	96.429
3/25/91	Navy	P	79	81.00	2	2.469	92.045
4/25/91	Air Force	P	42	36.00	-6	-16.667	97.297
6/25/91	Air Force	D	90	86.00	-4	-4.651	96.629
6/25/91	Air Force	D	282	280.00	-2	-0.714	96.552
6/25/91	Air Force	P	72	82.00	10	12.195	82.000
6/25/91	Navy	D	45	46.00	1	2.174	95.833
6/25/91	Navy	D	172	172.00	0	0.000	76.786
6/25/91	Navy	P	141	140.00	-1	-0.714	98.592
6/25/91	Navy	P	148	142.00	-6	-4.225	95.946
7/25/91	Air Force	P	721	707.00	-14	-1.980	96.717
7/25/91	Air Force	P	317	267.00	-50	-18.727	94.346
7/25/91	Navy	P	125	93.00	-32	-34.409	93.939

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
7/25/91	Navy	P	196	182.00	-14	-7.692	93.814
8/25/91	Air Force	D	98	90.00	-8	-8.889	100.000
8/25/91	Navy	P	71	57.00	-14	-24.561	116.327
9/25/91	Air Force	D	416	393.00	-23	-5.852	159.109
9/25/91	Navy	P	92	96.00	4	4.167	100.000
10/25/91	Air Force	P	832	800.00	-32	-4.000	96.618
10/25/91	Navy	P	532	548.00	16	2.920	98.032
10/25/91	Navy	P	260	187.00	-73	-39.037	97.906
10/25/91	Navy	P	39	36.00	-3	-8.333	85.714
11/25/91	Navy	P	158	145.00	-13	-8.966	96.026
11/25/91	Navy	P	106	104.00	-2	-1.923	95.413
12/25/91	Air Force	D	410	405.00	-5	-1.235	99.022
12/25/91	Air Force	D	169	169.00	0	0.000	98.256
12/25/91	Navy	P	261	189.00	-72	-38.095	98.953
12/25/91	Navy	P	201	166.00	-35	-21.084	94.857
1/25/92	Air Force	D	134	139.00	5	3.597	99.286
1/25/92	Air Force	D	76	64.00	-12	-18.750	96.970
1/25/92	Air Force	D	70	61.00	-9	-14.754	92.424
1/25/92	Air Force	P	632	580.00	-52	-8.966	98.472
1/25/92	Army	P	413	406.00	-7	-1.724	91.031
1/25/92	Navy	P	72	78.00	6	7.692	98.734
2/25/92	Navy	P	139	110.00	-29	-26.364	96.491
3/25/92	Air Force	D	118	105.00	-13	-12.381	82.677
3/25/92	Air Force	P	67	62.00	-5	-8.065	98.413
3/25/92	Air Force	P	315	242.00	-73	-30.165	97.581
3/25/92	Air Force	P	268	253.00	-15	-5.929	95.833
3/25/92	Navy	D	872	876.00	4	0.457	95.425
4/15/92	Navy	P	173	119.00	-54	-45.378	93.701
4/25/92	Army	D	308	233.00	-75	-32.189	132.386
4/25/92	Navy	P	1485	1173.00	-312	-26.598	99.239
5/25/92	Navy	P	173	148.00	-25	-16.892	98.667
5/25/92	Navy	P	573	604.00	31	5.132	97.419
5/25/92	Navy	P	573	604.00	31	5.132	97.419
5/25/92	Navy	P	217	194.00	-23	-11.856	96.517
5/25/92	Navy	P	348	350.00	2	0.571	93.085
6/25/92	Air Force	P	408	380.00	-28	-7.368	98.701
6/25/92	Navy	D	204	204.00	0	0.000	91.071
7/25/92	Navy	P	1216	1256.00	40	3.185	105.105
7/25/92	Navy	P	823	819.00	-4	-0.488	97.733
9/25/92	Air Force	P	116	118.00	2	1.695	85.507
10/25/92	Navy	D	1936	1781.00	-155	-8.703	116.405
10/25/92	Navy	D	63	39.00	-24	-61.538	95.122
10/25/92	Navy	P	116	115.00	-1	-0.870	96.639
11/1/92	Air Force	P	114	124.00	10	8.065	95.385
12/25/92	Air Force	D	18	18.00	0	0.000	100.000

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
12/25/92	Navy	P	134	129.00	-5	-3.876	94.161
12/25/92	Navy	P	135	132.00	-3	-2.273	92.308
1/25/93	Air Force	D	138	118.00	-20	-16.949	129.670
1/25/93	Air Force	P	165	165.00	0	0.000	96.491
1/25/93	Air Force	P	150	164.00	14	8.537	95.349
1/25/93	Air Force	P	223	223.00	0	0.000	94.492
1/25/93	Air Force	P	312	324.00	12	3.704	92.837
1/25/93	Air Force	P	241	244.00	3	1.230	86.833
1/25/93	Navy	P	138	132.00	-6	-4.545	96.350
2/25/93	Army	D	114	92.00	-22	-23.913	98.925
2/25/93	Navy	P	107	103.00	-4	-3.883	95.370
2/25/93	Navy	P	97	94.00	-3	-3.191	94.949
3/25/93	Air Force	D	114	91.00	-23	-25.275	95.789
3/25/93	Navy	P	566	523.00	-43	-8.222	176.689
3/25/93	Navy	P	30	34.00	4	11.765	97.143
3/25/93	Navy	P	109	115.00	6	5.217	95.833
3/25/93	Navy	P	266	222.00	-44	-19.820	95.690
4/25/93	Air Force	P	416	404.00	-12	-2.970	91.403
5/25/93	Army	D	65	38.00	-27	-71.053	100.000
5/25/93	Navy	P	216	194.00	-22	-11.340	97.000
6/25/93	Air Force	P	864	720.00	-144	-20.000	99.585
6/25/93	Air Force	P	69	59.00	-10	-16.949	96.721
6/25/93	Navy	P	24	32.00	8	25.000	100.000
6/25/93	Navy	P	74	76.00	2	2.632	93.827
7/25/93	Navy	P	808	789.00	-19	-2.408	98.996
8/25/93	Navy	P	272	222.00	-50	-22.523	114.433
8/25/93	Navy	P	455	513.00	58	11.306	95.000
8/25/93	Navy	P	658	626.00	-32	-5.112	85.636
9/25/93	Navy	P	173	174.00	1	0.575	79.452
10/25/93	Air Force	P	234	236.00	2	0.847	112.919
10/25/93	Navy	P	1475	1400.00	-75	-5.357	131.827
10/25/93	Navy	P	610	619.00	9	1.454	101.309
12/25/93	Navy	P	482	458.00	-24	-5.240	157.931
1/25/94	Navy	D	79	81.00	2	2.469	197.561
1/25/94	Navy	P	109	108.00	-1	-0.926	100.000
4/25/94	Air Force	P	106	102.00	-4	-3.922	96.226
4/25/94	Navy	P	1004	1001.00	-3	-0.300	98.234
5/25/94	Air Force	D	1088	1088.00	0	0.000	124.485
7/25/94	Navy	P	1441	1131.00	-310	-27.409	97.668
7/25/94	Navy	P	901	796.00	-105	-13.191	79.680
7/25/94	Navy	P	635	608.00	-27	-4.441	77.255
8/25/94	Navy	P	722	645.00	-77	-11.938	117.060
9/25/94	Air Force	P	115	122.00	7	5.738	91.045
9/25/94	Navy	P	110	111.00	1	0.901	96.522
10/25/94	Air Force	P	1147	958.00	-189	-19.729	106.800

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
10/25/94	Air Force	P	984	899.00	-85	-9.455	95.132
10/25/94	Air Force	P	1208	741.00	-467	-63.023	95.122
10/25/94	Air Force	P	910	577.00	-333	-57.712	94.435
11/25/94	Air Force	D	224	225.00	1	0.444	104.651
11/25/94	Air Force	P	27	16.00	-11	-68.750	76.190
11/25/94	Navy	P	442	468.00	26	5.556	95.122
12/25/94	Air Force	P	994	866.00	-128	-14.781	98.297
12/25/94	Air Force	P	764	728.00	-36	-4.945	96.296
12/25/94	Air Force	P	1478	1372.00	-106	-7.726	94.817
12/25/94	Air Force	P	638	550.00	-88	-16.000	90.016
12/25/94	Air Force	P	166	150.00	-16	-10.667	82.873
12/25/94	Army	D	129	134.00	5	3.731	84.810
1/25/95	Navy	P	1068	1062.00	-6	-0.565	96.898
2/25/95	Air Force	D	76	78.00	2	2.564	90.698
2/25/95	Navy	P	816	774.00	-42	-5.426	90.632
3/25/95	Navy	P	500	449.00	-51	-11.359	155.903
3/25/95	Navy	P	93	92.00	-1	-1.087	77.966
4/25/95	Air Force	D	8037	5141.00	-2896	-56.331	93.202
4/25/95	Air Force	D	117	83.00	-34	-40.964	88.298
4/25/95	Air Force	D	68	76.00	8	10.526	85.393
4/25/95	Air Force	D	8987	8467.00	-520	-6.141	80.985
4/25/95	Air Force	P	129	87.00	-42	-48.276	108.750
4/25/95	Air Force	P	1371	1340.00	-31	-2.313	96.195
4/25/95	Air Force	P	102	98.00	-4	-4.082	95.146
4/25/95	Air Force	P	626	576.00	-50	-8.681	93.204
4/25/95	Navy	D	17	16.00	-1	-6.250	94.118
4/25/95	Navy	D	20	19.00	-1	-5.263	79.167
4/25/95	Navy	P	1700	1738.00	38	2.186	91.763
4/25/95	Navy	P	548	539.00	-9	-1.670	81.667
5/25/95	Air Force	D	631	601.00	-30	-4.992	84.648
5/25/95	Air Force	D	100	74.00	-26	-35.135	75.510
5/25/95	Air Force	P	106	111.00	5	4.505	96.522
5/25/95	Army	D	136	141.00	5	3.546	89.809
5/25/95	Army	D	136	116.00	-20	-17.241	76.316
5/25/95	Army	P	216	222.00	6	2.703	91.358
5/25/95	Navy	D	177	164.00	-13	-7.927	128.125
5/25/95	Navy	P	962	1024.00	62	6.055	97.431
5/25/95	Navy	P	446	487.00	41	8.419	92.586
5/25/95	Navy	P	894	848.00	-46	-5.425	89.641
6/25/95	Navy	D	1092	1066.00	-26	-2.439	111.857
6/25/95	Navy	D	673	478.00	-195	-40.795	98.354
6/25/95	Navy	D	53	51.00	-2	-3.922	91.071
6/25/95	Navy	D	55	41.00	-14	-34.146	80.392
6/25/95	Navy	P	501	511.00	10	1.957	90.764
6/25/95	Navy	P	999	842.00	-157	-18.646	90.733

SUBMITDATE	SERVICE	PHASE	ACWP	BAC	CV	CV%	PC%
6/25/95	Navy	P	251	248.00	-3	-1.210	82.119

legend
Phase: P = production, D = development
CV: cost variance (final overrun)
CV%: cost variance percentage (final overrun percentage)
PC%: percent complete

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Vita

Capt David A. Searle was born on 27 May 1965 at Patrick AFB, Florida. He graduated from California State University at Fullerton in 1991 with a Bachelor of Arts degree in Business Administration and shortly thereafter entered the Air Force through Officer Training School. He is a 1992 distinguished graduate of OTS and received a regular commission.

His first assignment was at Misawa AB, Japan as a command and control officer with the 35th Fighter Wing, and in 1993 he was selected as the PACAF Command and Control Officer of the year. In May 1996, he entered the School of Logistics and Acquisition Management, Air Force Institute of Technology, in the Graduate Contract Management program. Upon graduation he will be assigned as a contracting officer at the Space and Missile Center at Los Angeles AFB, California.

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13. ABSTRACT (*Maximum 200 Words*)

This thesis examines the impact that recommendations made by the President's Blue Ribbon Commission on Defense Management, informally known as the Packard Commission, had on reducing cost overruns in major DoD acquisition programs. Cost overruns are a recurring problem in the DoD, and the study of possible effects resulting from the implementation of acquisition reform efforts such as the Packard Commission study could alter this trend. In this era of acquisition reform and downsizing it's important that policy makers understand the effects past and current policies have had and are having on reducing the ever present problem of cost overruns. Conclusions drawn in this thesis may guide and direct DoD policy makers in drafting future regulations and policies.

This study examined 269 contracts completed between January 1, 1988 and December 31, 1995. It was found that cost performance for contracts completed after the recommendations went into effect was poorer than cost performance prior to the change. It was also found that a more significant difference occurred between contracts in development phases than those in production phases. In fact, percentage cost overruns for development contracts nearly tripled after the policy went into effect. Possible explanations and implications of this discovery are provided.

14. Subject Terms

cost overrun, cost growth, Packard Commission, acquisition reform, acquisition policy

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