CAIV'S EFFECT ON SYSTEM ATTRIBUTES:

AN EXPLORATORY PILOT STUDY

By

Robert Stout

Thesis

Submitted to the Faculty of the

Graduate School of Vanderbilt

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

in

Management of Technology

May, 2005

Nashville, Tennessee

Approved:

David M. Dilts

William Mahaffey

To my family and friends, especially Evie, Dr. Dilts, and MJ

ACKNOWLEDGEMENTS

I would like to thank the MOT department, all residents of FGH 333,everyone who completed a survey, Dr. Mahaffey for bringing me into the program, Dr. Zadeh and Dr. Young for their help, and finally everyone who came before me in the MOT program whose example I could follow.

TABLE OF CONTENTS

APPENDIX

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The fiscal year budget for the Department of Defense in 2005 is $417.5 billion dollars (DoD, 2004). This money is used for everything from nanotechnology research to employee salaries to the development of defense weapon systems. However, the money does not go as far as the DoD would like it to, and to complicate the problem, cost and development time for on-going projects are increasing. Due to this problem many programs have made budget cuts and other programs are being completely shut down. For example, the Comanche helicopter was under development by the Army and Boeing for twenty years at the cost of $8 billion dollars (Army, 2004). In this time only two prototypes were ever built and the helicopter was still two years away from being ready for regular production. In February 2004 the Army decided to completely shut down the Comanche project in order to save money (Mount, 2004). The decision will save the Army money in the future, but it has cost them $2 billion dollars in order to make the decision a reality.

The problem of increased costs and longer development times has resulted in cost becoming the focus of many programs. To try to reduce cost the DoD has implemented a process known as "Cost as an Independent Variable" (CAIV) to help lower costs of new systems (Herald, 2000). CAIV was proposed in 1995 and approved in 1996 as part of the 5000 series regulations on defense systems acquisition with the goal being that cost is set and everything else is traded off to meet specifications and not exceed the set cost (DoD, 1996). CAIV treats cost as an input to a system rather than an output, meaning that cost is set at the beginning and is not changed in the life cycle of the program (Snodgrass, 2001). The idea behind this is that if the amount of money that will be spent is set, then developers will be unable to go over budget and therefore spending will be fixed. CAIV will be required on MDAP's (Major Defense Acquisition Programs: programs with Research and Development of $325 million and estimated costs of $2.19 billion or more) and MAIS's (Major Acquisition of Information Systems: systems with total estimated costs are $126 million and/or LCC of $328 million or more) (DoD, 2001).

The use of CAIV has resulted in some cost savings in the defense industry. Research shows that millions of dollars have been cut from the front end of system development (DoN, 2004). However, even though CAIV saves money, research needs to be done to determine

any other effects of CAIV on a system. A major issue that needs to be addressed is whether or not CAIV affects the performance of the system. If CAIV negatively affects performance then its use may not be warranted even though it saves money. Conversely, if CAIV can be shown to improve system performance, a stronger argument can be made for using CAIV.

The next major system aspect that needs to be investigated in association with CAIV is long-term system costs. CAIV does save money on the front end of system development, but it could possibly increases the long term cost of owning a system as well. If it increases the long-term costs, then the money saved in development may be cancelled. The last major aspect that needs to be investigated is life duration of systems that are developed using CAIV. If the use of CAIV shortens a systems usable life then cost savings in the beginning may not be worth the usable lifetime lost. These aspects need to be investigated to determine if CAIV's use should be continued in the defense industry.

This exploratory research increases the current level of knowledge in the field of CAIV and its relationship to finished systems. The goals of the thesis are to: 1) validate an instrument (the survey); 2) determine what affects CAIV could have on finished systems; 3) identify areas in which research is needed regarding the use of CAIV in system development. The systems that are investigated were identified by systems engineering experts, and a survey was constructed to investigate these areas. The survey was distributed to experts at several locations that use CAIV and field interviews were conducted to ensure that the survey questions were clear and well stated.

This thesis is divided into six sections. In the first section (the introduction) the problem is introduced and briefly overviewed. This section also explains the goals and structure of the thesis. The next section is the systematic review of the literature. The review investigates all literature that is relevant to the problem and presents the findings of this investigation. The third section is the presentation of the research model. The model shows the research aims and explains how the instrument was developed. The fourth section is the methodology of the thesis and it explains how and where the instrument was used for research. The following section is the results. The final section of the thesis is the conclusion that wraps up the findings and identifies areas for further research.

CHAPTER II

LITERATURE REVIEW

A systematic review of the literature was conducted in order to find all relevant information pertaining to Cost as an Independent Variable (CAIV) and Target Costing using the method proposed by Magarey (2001). A systematic review enables the researcher to determine what is already known in the field about the topic and also what holes or gaps of knowledge there are in the known information (Berry and Beckman, n.d, paragraph 1). Conducting a systematic review ensures that a comprehensive and unbiased review of all applicable knowledge is conducted. A systematic review also attempts to eliminate the bias of the researcher by exploring all relevant information and studies and not just the ones that support the researcher's hypothesizes or opinions (Magarey, 2001). The process starts by identifying the key words for the study. Key words are used as queries to search databases, libraries, and books. The results from the searches are then analyzed and filtered to determine what does and what does not pertain to the research in question. The structure of the review ensures that unbiased and complete information is gathered from the available literature.

The first step in the systematic review of literature was to identify the key terms for the search. The key words that were used in the review are listed in Table 1. The words that are in *italics* comprised the main focus of the study. The other words listed below were taken from definitions and characteristics of CAIV and Target Costing respectively (Webster and Watson, 2002). Since the words were identified in definitions and characteristics of each practice, they were included in the searches as well. Including these additional words in the searches ensured that nothing was missed in the review of the literature.

The review of the literature consisted of several steps. First a search was conducted for each key word or phrase individually. Then a search was conducted using each key word or phrase in conjunction with a focusing word (see Table 2). This process revealed articles that were not found searching only with the key words. The reasoning for doing this was to find all information pertaining to CAIV and Target Costing.

The next step in the process was to determine where to search. It was quickly decided that Vanderbilt's library was exactly what was needed due to its extensive accesses to academic databases, government documents, academic journals, and books. Sources were then

collected using all relevant databases. Processes, methods, definitions, studies, case studies and examples associated with CAIV and Target Costing were explored. The review looked at all information on how CAIV and Target Costing is performed by companies, what results are expected from the use of CAIV and Target Costing, case studies of companies that demonstrated the pros and cons of each system and any other relevant aspect of each costing system. Since the topic did not exist until 1965, the search included all dates, which ensured the searches' thoroughness. However, the searches were initially limited to peer-reviewed journal articles contained in the databases (see Table 3). After the databases were searched, additional searches were conducted of Department of Defense (DoD) Defense Link, Department of the Navy (DoN) Acquisition One Source, International Council on Systems Engineering (INCOSE), Consortium for Advanced Manufacturing International (CAM-I), and Institute of Electrical and Electronics Engineers (IEEE) in order to find any other pertinent information from working papers, conferences, or DoD documents. Next a physical search was performed with the aid of a reference librarian in the government documents section of Vanderbilt's Jean and Alexander Heard Library and also in Vanderbilt's Walker Management library. These physical searches further ensured that the information was complete.

The searches of databases, documents, journals and books resulted in 6,760 articles, books, and conference proceedings relevant to CAIV and Target Costing. The breakdown of results is displayed (see Table 4). Next the articles were examined to determine which articles did not pertain to the study in question. The first step involved reading the titles of all of the articles. This method eliminated a vast number of articles because many were off-topic. For example, many of the CAIV searches came back with information pertaining to a medical vaccine, which has no relevance in a study on costing. Reading the titles of the fixed cost articles revealed that many results had nothing to with this study. Although these eliminated articles were relevant to costing, they were concerned with cost that had to be spent in order for a business to operate (a fixed cost) which is not pertinent to CAIV and Target Costing systems. All titles were examined and 6,414 articles that were not pertinent were discarded. The process in which this was done is shown in Figure 1.

The search then focused on the abstracts of the articles. Reading the abstracts enabled the researcher to determine the focus of the articles and whether or not the articles are relevant to the study. This step reduced the volume of results down to 97 articles (from 346). The full text of

all of the remaining articles was then read and those articles that did not pertain to the study were discarded.

The elimination process resulted in 48 articles, which is much more manageable than the original count of 6,760. The steps of the process and results of each step can be seen in detail in Figure 1 above. Out of the 48 final results, 29 pertained to Target Costing while the remaining articles were relevant to CAIV. Three of the 29 Target Costing results were books and the other 26 were articles found in the databases listed in Table 3. All 19 of the final resources for CAIV were articles or DoD regulations. No books were found relating to CAIV. Table 5 presents an analysis of the final articles chosen for the literature review. Table 6 and 7 show the results for CAIV and Target Costing respectively. Since the keywords other than CAIV and Target Costing were employed as supplements to these two integral key words, the final results of the searches were categorized according to their relevance to CAIV and Target Costing and not according to the additional key words from Table 1 that comprise subcategories of CAIV and Target Costing. Note that numerous articles were repetitive and stated the same findings and opinions. Not all of the articles are cited within the text of this paper due to their repetitive nature, but all sources are listed in the bibliography.

Most of the articles that pertained to CAIV presented basic CAIV information, how CAIV should be implemented in practice, the author's opinion of CAIV, or how CAIV was used to save money in the onset of a project. The searches revealed no articles that presented data as to whether or not CAIV improved final product performance or whether the use of CAIV increased or decreased the cost of a product throughout its life.

The literature concerning Target Costing was mainly composed of tutorials on how to implement Target Costing and basic information about Target Costing. Most articles presented case studies of companies in which Target Costing was effective. The articles that presented basic information were included in the basic information category even if they also involved a case study. Only articles that presented case studies exclusively were included in the case study category. CAIV was categorized in the same fashion. The focus of the literature review was to find all information available to Cost as an Independent Variable and Target Costing. Both systems are reviewed and the successes that each system has had are presented in the following pages.

Cost as an Independent Variable

Cost as an Independent Variable (CAIV) is a method that was developed by the DoD to cut costs on projects. CAIV was proposed in 1995 and was approved in March of 1996 by the DoD (DoD, 1996). CAIV is defined in Section 3.3.4 of DoD 5000.2.R, as,:

> "…a process that helps arrive at cost objectives (including life-cycle costs) and helps the requirements community set performance objectives. The CAIV process shall be used to develop an acquisition strategy for acquiring and operating affordable DoD systems by setting aggressive, achievable cost objectives and managing achievement of these objectives. Cost objectives shall also be set to balance mission needs with projected out-year resources, taking into account anticipated process improvements in both DoD and defense industries."

CAIV's most important objective is to reduce overall costs for the total life of a new system (Snodgrass, 2001). CAIV is normally utilized at the beginning of a project's life cycle, in the planning phase. CAIV developed due to schedule and cost growth common to performance driven development processes (Herald, 2000). An evaluation of a large sample of DoD programs prior to 1995 indicated that more than 80 percent have cost and/or schedule growth (Conrow 1997). Another study by Christensen (1999) examined finished contracts using the Defense Acquisition Executive Summary (DAES) database. Christensen examined 269 contracts between 1988 and 1995 and determined that any reform employed to lower project cost overruns did not work, and that the average project cost overrun was 20 percent (Christensen, 1999). Due to such cost overruns, CAIV was developed and approved in an attempt to reduce the cost of development and also the long-term cost of a project.

The foundation of CAIV rests in two primary principles: total costs are capped and trade space is the foundation for informed decisions (Gotwald et al, 2000). Capping cost is a way of containing the costs of projects and programs. In doing this, the DoD will know exactly how much money it is going to spend in all phases of a program and it will not have to put additional money into a project to have it completed. Capped costs are important since very few large programs are completed on schedule and within cost (Rickman, 2001). The principle that trade space is the foundation for informed decisions basically means that decision makers will have more alternatives that directly influence cost in a project (Snodgrass, 2001). The principle is specified by DoDD 5000.1, which states "acquisition managers shall establish aggressive but realistic objectives for all programs and follow through by trading off performance and

schedule, beginning early in the program (when the majority of costs are determined) to achieve a balanced set of goals." Having alternatives and using trade-offs is CAIV's attempt to give the user the "most bang for the buck" (Herald, 2000).

Trade space is a critical component of systems engineering (Buede, 2000). When a system is being developed it is crucial to review all options available for the system (Blanchard, 2004). Using the trade space the developer is able to meet the requirements for the system set by the customer by analyzing all of the available options (Buede, 2000). Such a trade space will allow the decision-maker to choose the alternative that best meets the system's performance and cost goals.

CAIV theoretically works in three fundamental ways. First it attempts to provide the customer with a superior system that is affordable for the life of the system (Snodgrass, 2001). It does this in setting price and forcing trade-offs to get the "best" system for the amount of money specified. Trade-offs are made for everything in the system, from the design of the project down to the actual components that will be used. The use of trade-offs enables the contractor to explore all available options and make the best product for the amount of money allowed in the contract. CAIV also provides a method to establish and adjust performance requirements to fit the cost objectives (Conrow, 1996). CAIV executes this with cost performance analysis and trade-offs in the trade space of a program. Finally, CAIV defines all cost objectives and key performance parameters (KPP) before the request for proposal (RFP) is sent (Gotwald et al, 2000). Defining cost objectives and performance parameters forces industry to meet or exceed the performance requirements specified without exceeding the cost. Since the cost and performance parameters are set before the RFP, the contractor and the DoD have clear expectations of cost once the contract has been accepted.

CAIV has been approved and will be used on several flagship programs to determine in the DoD. These programs include EELV (an evolved expanded launch vehicle), AIM-9X (an air to air missile), TACMS-BAT P31 (upgrade of new ground to ground missile), MIDS (jam resistant communication for the NATO family), JASSM (a long range air to surface standoff missile), CRUSADER (self propelled Howitzer and armored resupply vehicle), JSF (advanced strike fighter aircraft), and SBIRS (space based infrared surveillance system) (Rush, 1997; Mckinney 1999). All of these programs are multimillion-dollar programs; for example the EELV alone is a $1 billion dollar project (Mckinney, 1999).

CAIV has saved money in several projects, one of which was adding a

commercial cockpit in the E-6 Aircraft (DoN, 2004). The program used CAIV practices to ensure that requirements and performance growth did not affect cost thresholds. In doing this, the program was able to save $13.98 million in the production effort (DoN, 2004). Another success is Joint Standoff Weapon Program where their use of CAIV resulted in $643 million dollars of cost avoidance (DoN, 2004). There are other examples of CAIV saving millions of dollars for the government in the defense industry (DoN, 2004). However, the examples only show money that CAIV has saved in the development process. No studies were found that indicated that CAIV increased or decreased performance of the projects, or whether or not it increased or decreased the cost of the total project life-cycle cost.

Target Costing

While CAIV is used in Defense contracts there is a practice that is common in the private sector that is analogous to CAIV. Known as Target Costing, it was invented by Toyota in 1965 (Tanka, 1993). Target costing is a way for companies to manage future profits by determining life cycle costs, performance, and quality needed to ensure a profitable product (Cooper 1996). Similar to CAIV, Target Costing makes cost an input to the development process instead of an output. However, unlike CAIV, Target Costing is concerned with making a profitable product. Target Costing is defined by the CAM-I group as:

> "Target costing is a process in a system of profit planning and cost management that is price led, customer focused, designed centered, and cross-functional. Target costing initiates cost management at the earliest stages of product development and applies it throughout the product life-cycle by actively involving the entire value chain." (Anasari and Bell, 1996, p11)

The CAM-I target cost core group put forth that Target Costing is different from traditional cost management in six key ways: price-led costing, customer focus, focus on the design of products and processes, cross-functional teams, life-cycle cost reduction, and value chain involvement (Anasari and Bell, 1996). Price-led costing involves letting the cost of a product be an input to the system. This means that the cost of the product will be decided upon before the product is designed, not after the product is designed (Swenson, 2003). Customer focus is very important in Target Costing because customers are consulted for their input in all stages of product development. Customer focus allows a Target Costing firm to better determine what the customer wants and to deliver it to them. Focus on the design of products and processes means that the firm concentrates on the design of its products and also how they

will be designed to cut cost. This is done by decomposing the design and setting cost targets for each function (Lee, 1994). The functions are ordered according to importance, and tradeoffs are made between them. The more important functions are given priority. Cross-functional teams are very important to Target Costing; these teams are made up of individuals from all involved areas of the company (Gagne and Discenza, 1995). Through these teams, Target Costing is able to make use of everyone's knowledge, a model that is better suited for designing new products. These teams also force communication among departments, which has resulted in increased information sharing within and between the firms (Cooper, 1997). Life cycle cost reduction is another important aspect of Target Costing. This part of Target Costing means that the firm does not stop once a product is produced but continues to look for ways to cut costs throughout the products entire life (Shank and Fisher, 1999). Value chain involvement refers to the process by which the firm works with the supply chain to cut cost. Suppliers are consulted for their opinions and rewarded for cutting costs (Slagmunder and Cooper, 1999).

Cooper has done extensive research in the field of Target Costing, and has seen how companies have succeeded using these six principles. Cooper examined seven different Japanese companies to determine the underlying principles for Target Costing. These firms include Isuzu Motors Ltd., Komatsu Limited, Nissan Motor Corporation, Olympus Optical Company Ltd., Toyota Motor Corporation, Sony Corporation, and Topcon Corporation (Cooper, 1996). These firms have saved millions of dollars and improved their businesses in many ways by employing Target Costing (Cooper, 1996). In America, several firms have used Target Costing and its procedures. Caterpillar was able to use Target Costing to eliminate non-value adding activities and in turn increase its revenues (Kroll, 1997). Chrysler is another example of an American firm successfully using Target Costing. In 1990 they implemented a form of Target Costing and by 1994 they had increased it their profits and cash flow by 400 percent (Anasari and Bell, 1996). Each firm uses a different version of the practice, but all of the versions have the same goal in mind and use the same basic principles (Pringle, 2001).

Target costing starts with forcing alignment with the market place and determining what customers specifically want and how much they are willing to pay for what they want (Tani, 1994). This is known as market-driven costing. Market-driven costing can be broken down into five steps, the first of which is to set the company’s long-term sales and profit objectives (Cooper 1997). The purpose of this step is to make sure that the product will contribute to the long-term profits of the company. This is key because if the product is not going to be profitable there is

no reason to make it. The second step is to structure the product lines to achieve maximum profitability (Cooper 1997). This is done to effectively determine the customer's needs over time and to satisfy as many customers as possible. The third step is to set the target-selling price (Kato, 1993). Determining this price is critical; companies need to determine how much a customer is willing to pay and what the perceived value of a product is. Doing this helps the company determine the price of the product. Functional analysis, the fourth step, is used here functional analysis is a cost management system that focuses on the various functions of a product and becomes a list of cost based on the functions (Yoshikawa, 1990). The final step in market-driven costing is to establish the target profit margin (Cooper 1997). The target profit margin is how much the company needs to make on each product to meet the long-term profit plan of the company. Once the target profit margin and the target selling price of a product have been determined, the allowable cost is determined. The allowable cost is a simple formula:

Allowable cost = target selling price – target profit margin

Once the allowable cost has been determined the cost of the product or project can be set.

After the allowable cost has been determined, the company focuses on product and component level Target Costing. Thus the product is decomposed into functions and components, and tradeoffs are made depending on the functions' importance (Monden, 1997). The design team uses the tradeoffs to meet the cost targets that were previously set for the functions and components (Monden, 1997). Once the costs have been determined, the cardinal rule should be applied, "The target cost must never be exceeded" (Cooper 1997). It is crucial for companies to stick to the target cost. Otherwise they will be unable to meet the long-term profits that they specified at the onset of applying Target Costing. Using Target Costing companies have been able to increase their sales and revenues; an example is Olympus Optical Company, LTD. The company implemented a Target Costing system and was able to increase their camera sales by almost 70 percent (30 billion to 70 billion Yen) and almost double their market share for compact cameras (Cooper, 1997).

Value engineering is an integral part of Target Costing (Webb, 1993). Value engineering is a systematic approach to seek out the best functional balance between cost, reliability, and performance of a product (Williamson, 1997). Value engineering allows the company to identify functions that add cost but do not add performance and eliminate them, thus reducing

the cost of the system and increasing the value of the system. Value is defined as follows:

Value = function/cost or Perceived Value = perceived benefits/price

(Anasari and Bell, 1996). Value engineering allows the product to be designed from multiple view-points to determine the best value for the money (Gagne 1995). Every firm tailor fits value engineering to their specific needs hence value engineering is performed differently in different companies. However, the overarching goal remains the same: to eliminate any part of the product that is not value adding (Gagne 1995). Normally this is done by decomposing the design into functions and then further into components and assessing all parts at each step. This ensures that the entire product is reviewed and not just pieces (Anasari and Bell 1996). The success of value engineering depends on a dedicated work force and knowledgeable employees (Anasari and Bell, 1996).

The use of value engineering can make a large difference in the success of Target Costing at any firm (Cooper, 1997). For example, value engineering was used at PCBM, a silicon valley based PCB manufacturer, to reduce the costs of their PCBs for a specific order (Lee, 1994). Through value engineering activities they were able to reduce the cost of each PCB by $3 dollars, and by doing so save $30,000 dollars on the 10,000-unit order (Lee, 1994). Without the use of value engineering activities the firm would have been unable to meet their target costs. Another example of a company having great success with value engineering is Isuzu Motors Inc. Isuzu implemented a very extensive value engineering system in the early nineties. Through the work of their value engineering team, the company was able to identify savings worth 2.2 billion Yen (Cooper, 1997).

CAIV and Target Costing

There are five main aspects that CAIV and Target Costing have in common (see Table 8). The first is that they both set the price of the product before the product is designed. Because of this both systems should have similar results. Next, they both focus on requirements that are capabilities-based. This allows both systems to focus on how to meet the performance parameters that were specified during the initial phase. Also, both CAIV and Target Costing share the use of tradeoffs to meet the cost targets that have been set. Using tradeoffs enables both systems to find the optimal design for the system. Both systems use cross-functional

teams to design products, and in doing so involve knowledgeable people in the design procedure. This process produces the best design for the product, and it makes sure that multiple departments participate in designing the product. The final aspect that the systems have in common is a focus on reducing the cost of a product throughout its life cycle.

However, there are some differences between the two cost management systems as well (see Table 9). The first major difference is that Target Costing involves determining profit margins. Much time and effort is spent in this area to determine reasonable and necessary margins to keep the company on track for long-term finances (Anasari and Bell, 1996). Companies become exceedingly aware of how important it is to meet cost due to the fact that profits have to be made to stay in business. CAIV projects are also concerned with profits but it may not be as critical as in most Target Costing companies due to the fact that the projects that use CAIV are under contract. Another major difference between the two is that companies that have had success with Target Costing have products that have shorter life cycles, while most DoD projects have longer life cycles (Pringle, 2001). Another difference is that Target Costing is used exclusively in the private sector and CAIV is used solely in Defense Contracts (Cooper, 1997 and Kaye, 2000).

Conclusions from Literature Review

Target Costing research has shown it to be successful in saving companies money, generating larger profits, and also improving business practices. No studies were found that examined how Target Costing affected the performance of the product or how Target Costing affected the long-term life costs of the product. It is important to determine whether Target Costing is saving money through out a projects life or if it is causing performance problems. If Target Costing is saving large amounts of money in the beginning of a project's life but increasing maintenance costs or ownership costs of products it may not be worth using. The same goes for the performance issues, if Target Costing saves money on the front end but delivers a product with sub-par performance then the money saved is not justified.

Performance issues need to be explored to make sure the use of the costing system is warranted. CAIV has many similarities with Target Costing that would lead to the conclusion that CAIV will also have success saving money in the defense industry. However, no studies were found that researched any performance issues with CAIV or the long-term cost of using CAIV. These issues need to be addressed to make sure the using CAIV is a worthwhile way

to develop products. If CAIV saves the government millions of dollars in the beginning of the products life, but costs them much more later it is possibly not worth using. Setting the cost could potentially set up some projects for failure or abandonment due to performance issues or inability to meet specified performance parameters. The review of literature found a lack of research in the area of CAIV and performance issues or in the area of long-term project costs. More research is needed in order to determine whether CAIV will cause performance issues, long term cost increases, or shorter life duration than intended. The literature review leads to two main research questions: 1) If CAIV is being used, is it being used correctly; and 2) What affect does CAIV have on systems when it is used in the systems development?

Table 1: Key words used in search

Key Words		
CAIV	Cost	Ceilings
Cost as an Independent Variable	Fixed Cost	
Target Costing	Set Cost	
Cost Targets	Firm Fixed Price Contract	
Market Driven Costing	Value Engineering	

Table 2: Focusing words

Focusing Words		
Performance	Product	Quality
Quality	Product Performance	
Strategy	Product	
Survey	Component	

Table 3: Databases that were searched

Databases	
ProQuest	Web of Science
InfoTrac/Onefile	IEEE Xplore
JSTOR	Business Source Premier
Jake	Lexis Nexis Academic
Vanderbilt Online Thesis & Dissertations	DoN Acquisition One Source
DoD Defense Link	CAM-I
ProQuest – Digital Dissertations	Acquisition Community Connection
INCOSE	

Table 4: Results of the Search

Results	
Key Word	*Number of Found Articles*
Fixed Cost	4940
Set Cost	701
Value Engineering	448
Cost as an Independent Variable	193
Target Costing	166
Cost Targets	149
CAIV	91
Firm-Fixed Price Contracts	50
Cost Ceilings	13
Market Driven Costing	9
Total	6760

Table 5: Results of the Search after Reading Abstracts and Titles

Key Word	Basic Overview of Costing Practice	Case Study	Opinion	Book Review	Total
Cost as an Independent Variable (CAIV)	13	3	3	0	19
Target Costing	18	8	1	2	29
Total	31	11	4	2	48

Table 6: CAIV Sources

Author	Year	Title	Source
Def. Acquisition University	2004	ACC home page	Web
Department of Defense	1996	Defense Acquisition	DoD Reg.
Department of the Navy	2004	Acquisition One Source	Web
Chappelle, Douglas E	2000	Are there too many MBAS in Aerospace	IEEE
Christensen, David S, et al	1999	Reducing Cost Overruns	Acquisition Review Quarterly
Christensen, David S, et al	2002	EAC Evaluation Methods	Acquisition Review Quarterly
Conrow, Edmund H	1996	Benefits of Using CAIV	Project Manager
Criscimagna, Ned H	1998	CAIV	S.T.A.R.T
Cummings, John	1997	CAIV involves Systems User	Logistics Spectrum
Department of Defense	1998	Defense Contracts	Defense Daily
Department of Defense	1996	DoD Regulation 5000	DoD Reg.
Gotwald, Allen et al	2000	CAIV: Principles and Implementation	Acquisition Review Quarterly
Herald, Thomas E.	2000	Systems development Process and CAIV	IEEE
Hildebrandt, Gregory G	1998	Performance Incentives in DoD Contracting	Acquisition Review Quarterly
McKinney, Col. Richard W	1999	EELV meets CAIV	Aerospace America
Parker, Miles	1997	Improving Design and reducing costs	IIE Solutions
Rickman, Dale M	2001	A New Process For Requirements Understanding	IEEE DASC 2001
Rush, Dr. Benjamin	1997	CAIV: Concepts and Risks	Acquisition Review Quarterly
Snodgrass, Alan	2001	CAIV	Proposal Mngt

Table 7: Target Costing Results

Author	Year	Title	Source
Albright, Tom et al	2003	Competitive Environment of TC	American Banker
Anasari & Bell	1997	Target Costing	Book
Brausch, John M	1994	Beyond ABC: TC for Profits	Mgmt. Acct.
Bruggeman, Werner	2002	Cost Targets and Time Pressure	Intl. Jnl. OPM
Cooper & Kaplan	1991	Design of Cost Mgmt. Systems	Book
Cooper & Slagmulder	1997	Target Costing	Book
Cooper & Slagmulder	1999	Develop Profitable new Products	Sloan Mgmt. Rev.
Creese, Robert C.	1999	Target Costing and Value Eng.	Cost Eng.
Dekker and Smidt	2003	Survey of Adoption in Dutch	Int. Jnl. Prd. Econ.
Fitzgerald, Kevin R	1997	Cost tops all Concerns	Purchasing
Freeman, Tom	1998	Cost Mgmt. Into Strat. Weapon	CAM-I
Gagne and Discenza	1995	Target Costing	Jnl. Bus. Ind. Mrkt
Kato, Y	1993	Target Costing Support Systems	Mgmt Act. Res.
Kroll, Karen	1997	On Target	Industry Week
Lee, John Yee	1994	Use Target Costing	CPA Journal
Monden,Yasuhiro et al	1997	Target Costing: Lab Experiment	Mgnl. Dec. Econ.
Pringle, Peter	2001	Life Cycle Process	Man. Eng.
Redfern, Merlin	2004	Value Engineering	R&D
Sakurai, M	1989	Target Costing	Jnl. Cost Mgmt
Shank and Fisher	1999	Case Study: Target Costing	Sloan Mgmt Rev
Steedle, Lamont F	2000	Target Costing	Is. Acct. Edu.
Swenson et al	2003	Best Practices in Target Cost.	Mgmt Act Qt.
Tanka, T	1993	Target Costing at Toyota	Jnl. Cost Mgmt
Tani, et al	1994	Target Cost Mgmt in Japan	Mgmt Acct Res
Webb, Alan	1993	Value Engineering Part 1	Eng. Mgmt Jnl
Webb, Alan	1993	Value Engineering Part 2	Eng Mgmt Jnl
Willaimson, Andrew	1997	Target and Kaizen Costing	IEE Man. Eng.
American Banker	1999	Sys. Approach to cost cutting	American Banker
Yoshikawa, T	1990	Emerging Cost Management	Book

Table 8: CAIV and Target Costing Commonalities

CAIV and Target Costing Commonalities
1. Price of product is set before product is designed (cost input rather than output) 2. Capabilities-based requirements 3. The use of trade-offs to meet cost targets/goals 4. Cross-functional design teams 5. A focus on cost reduction throughout life cycle

Table 9: CAIV and Target Costing Differences

CAIV and Target Costing Differences	
Target Costing	*CAIV*
Focuses heavily on what the market will bear, profit margin, and selling price	Does not
Products have short life cycles	Products have long term life cycles
Used exclusively in private sector	Used exclusively in contracted government projects

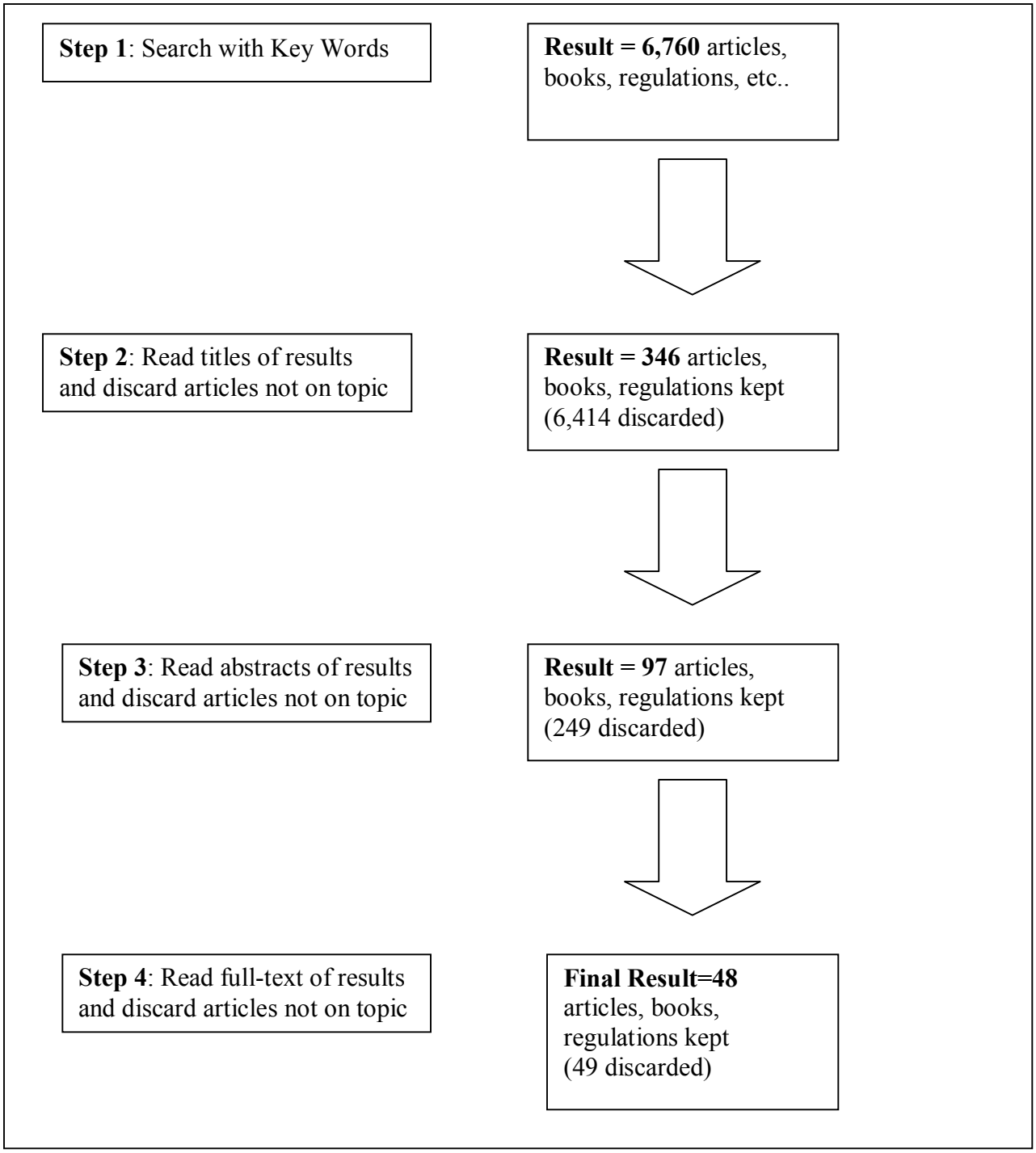

Figure 1: Result Reduction Process

CHAPTER III

RESEARCH MODEL AND DEVELOPMENT OF INSTRUMENT

The goal of my research (see Figure 2) is to determine the effects of CAIV on system development by investigating the attributes of a finished system on which CAIV was used. The model was developed based on important aspects of system development, CAIV principles, and finished systems that were identified from literature.

The model begins with *System Development* which is a company starting a new system or refurbishing an old one. The *System Development* is the period from concept to production of a system. The *System Development* block is affected by two different factors: the characteristics of the system and the characteristics of the business unit (Blanchard, 2004; Buede, 2000; Anasari and Bell, 1997). Variances among system characteristics could aid in determining how successful the system will be. The type, size, and development duration of a system could affect CAIV's influence on the system (Buede, 2000). For example, a legacy system may not be affected by CAIV in the same way that a completely new system would be. The size of the system is also important to determine because CAIV may not affect a small and inexpensive system at all or it may affect the same system tremendously. Duration of the development process is also important. If a system is developed very quickly then problems that arise could be the result of a rushed development as opposed to CAIV (Anasari and Bell, 1997).

The characteristics of the business unit can also directly affect the system (Anasari and Bell, 1997). Depending on the type of industry, the number of people, their experience, and their priorities, the business unit could have great success with one type of system and complete failure with others (Blanchard, 2004). This makes it imperative to identify the characteristics of the business unit. Identifying the characteristics of the system, and those of the business unit, allows the researcher to identify factors other than CAIV that have an effect on the finished system attributes.

How a system is developed directly affects the attributes the system will have when it is finished. The use of CAIV affects the system development by limiting the resources that can be used for the system. CAIV could possibly have a number of different effects on a finished system's attributes.

The *Finished System Attributes* can be decomposed into three major areas:

performance, cost(s), and life duration. The overall system performance of the system is an extremely important aspect (Blanchard, 2004). If the system does not meet or meets only the minimum performance parameters or conversely, it exceeds the performance parameters that it is supposed to, it is important to find out why. The cause could be any number of things that are identified in the *System Development* block or possibly it could be the result of using CAIV.

The cost of owning the system throughout its life is another important aspect of the system that needs to be examined (Buede, 2000). If CAIV increases the cost of owning the system throughout its life, it can be said that it is not worth using CAIV. On the contrary, if CAIV decreases the cost of owning the system throughout its life, then CAIV's use will be important and beneficial.

Another important area of the finished system attributes is the life duration of the system (Bahill and Dean, 1999). My research will determine how CAIV affects the system's longevity (how long the system is usable). This aspect is important because if CAIV makes a system's usable life very short, then it may not be desirable, or if it extends a system's life it could be very desirable.

Hence, using this model, this study will: 1) determine what types of systems and business units are using or have used CAIV; 2) determine how CAIV is being used; 3) determine what affect CAIV could have on finished systems; and 4) determine themes for further research.

Development of the Instrument

Using the Research Model, there are three major areas in which the instrument attempts to investigate: 1) System Development (system and business unit demographics), 2) CAIV principles, and 3) Finished System Attributes. For each area a list of variables was identified by a literature review and from the literature review a survey was constructed (see Appendix B).

System Development (Demographic Information)

The first section of the survey is system demographic information (see survey Appendix B). For system demographic variables, we have included: where the system is in its lifecycle, development time, number of people involved, expected operational life of the system, changes made to the system, money initially committed to the system and also the name of the system if possible. These variables were incorporated into the questions in the survey, and their references are listed (see Table 10).

After system demographics were identified, the next area that needed to be investigated by the instrument was the demographics of the business unit that would be using CAIV. For business unit demographics we included: business industry, functional area of the business unit, actual business unit description, number of people in the business unit, business characteristics, and where the business unit places its importance (see Table 11).

CAIV characteristics

The next section of the survey investigates the characteristics of CAIV and its implementation. For the costing method CAIV, there are many small characteristics, but the literature review revealed that there were five major characteristics of CAIV: cost of system is set before its designed, tradeoffs are used to reduce costs, requirements are capabilities based, cross-functional teams, and focus on cost reduction throughout the system's life. Other variables associated with CAIV's use are included in this section as well: adoption reasons, how long CAIV has been used, why CAIV was adopted, depth of implementation, how CAIV was implemented, principles of the CAIV system, changes associated with using CAIV (this deals with the finished system attributes), perceived success, whether or not it will be extended, and whether or not it will be used again. These variables were incorporated into the questions in the survey, and their references are listed (see Table 12).

Finished System Attributes

Finally the survey investigates the attributes of the finished system developed with CAIV. The finished system attributes were identified from the literature and the attributes that were included were: cost (to develop, to maintain, to operate, profitability) time (to develop, life duration), customer satisfaction, and performance. (see Table 13)

Development of the Questionnaire

The questionnaire was adapted directly from the CAM-I survey. Several questions that were not applicable to the study were completely removed and many questions were slightly changed to better fit the research model. The decision to do this was a fairly easy one since their survey had already been verified. Using the CAM-I survey was easier because it allowed the researcher to know exactly what needed to be included in the questionnaire and what did not.

The questionnaire and method were sent to the Institutional Review Board (IRB) at

Vanderbilt University and was approved (IRB# 041108) on January 5, 2005. The final version of the questionnaire is attached in Appendix B, and the CAM-I survey can be accessed online at http://www.cam-i.org/TC/survey.html.

Table 10: System Demographics and References

System Demographic Survey Questions	References
System Information: ❑ Development Length? ❑ People Involved? ❑ System's Expected Life? ❑ System Modifications/Changes? ❑ System cost?	"Acquisition Community Connection home page" Retrieved September 5, 2004 from http://acc.dau.mil/simplify/ev_en.php?ID=1433_201&ID2=DO_TOPIC Asiedu, Y. and Gu, P. (1998) "Product Life Cycle Cost Analysis: State of the Art Review," *International Journal of Production Research*, 36(4): 883-908. Bahill, Dean, Sage, Rouse (1999) *Handbook of Systems Engineering and Management*. Hoboken, NJ: John Wiley & Sons Blanchard, Benjamin. (2004) *Systems Engineering Management.* Hoboken, NJ: John Wiley & Sons Buede, Dennis (2000) *The Engineering Design of Systems (Models and Methods)*. Hoboken, NJ: John Wiley & Sons Cooper, Robin and Slagmulder, Regime (1997) *Target Costing and Value Engineering*. Portland, Or: Productivity Press "DoD Defense Link home page" Retrieved September 5, 2004 from http://www.defenselink.mil/search/ "DoN Acquisition One Source Home page" Retrieved September 5, 2004 from http://www.abm.rda.hq.navy.mil/navyaos/content/view/full/128 Herald, Thomas E. (2000) "Technology Refreshment Strategy and Plan for Application in Military Systems – A How to Systems development Process and Linkage with CAIV" *IEEE Conference Proceedings* pp.729-736. Rush, Dr. Benjamin (1997) "Cost as an Independent Variable: Concepts and Risks" *Acquisition Review Quarterly,* (Spring): 161-172. "Target Costing Best Practices Survey" Retrieved October 3, 2004 from http://www.cam-i.org/TC/survey.html

Table 11: Business Unit Variables and References

Business Unit Demographic Survey Questions	**References**
Business Unit (BU) Information: ❑ Industry? ❑ Area? ❑ Actual BU description ❑ People in BU? ❑ Characteristic? ❑ Where BU places importance?	"Acquisition Community Connection home page" Retrieved September 5, 2004 fromhttp://acc.dau.mil/simplify/ev_en.php?ID=1433_201&ID2=DO_TOPIC Anasari, Shahid L., and Bell, Jan E. (1997) *Target Costing : The Next Frontier in Strategic Cost Management*. Chicago, IL: Irwin Professional Publishing Asiedu, Y. and Gu, P. (1998) "Product Life Cycle Cost Analysis: State of the Art Review," *International Journal of Production Research*, 36(4): 883-908. Cooper, Robin and Slagmulder, Regime (1997) *Target Costing and Value Engineering*. Portland, Or: Productivity Press Fabrycky, Wolter and Blanchard, Benjamin (1991) *Life-Cycle Cost and Economic Analysis*, Englewood Cliffs, NJ: Prentice-Hall, Inc. "Target Costing Best Practices Survey" Retrieved October 3, 2004 from http://www.cam-i.org/TC/survey.html "DoD Defense Link home page" Retrieved September 5, 2004 from http://www.defenselink.mil/search/

Table 12: CAIV characteristics and References

CAIV characteristics and implementation Survey Questions	**References**
CAIV characteristics and implementation information: ❑ Characteristics? ❑ Definition ❑ Adoption factors? ❑ Length of Use? ❑ Decision? ❑ Depth of CAIV ❑ How implemented? ❑ Results of using? ❑ Perception of Success? ❑ Extended? ❑ Used again?	"Acquisition Community Connection home page" Retrieved September 5, 2004 from http://acc.dau.mil/simplify/ev_en.php?ID=1433_201&ID2=DO_TOPIC Anasari, Shahid L., and Bell, Jan E. (1997) *Target Costing : The Next Frontier in Strategic Cost Management*. Chicago, IL: Irwin Professional Publishing Department of Defense. (1996, March 15). DoD Regulation 5000. 2-R, Part 3. "Defense Acquisition," DoDD 5000.1, March 15, 1996. "DoN Acquisition One Source Home page" Retrieved September 5, 2004 from http://www.abm.rda.hq.navy.mil/navyaos/content/view/full/128 Herald, Thomas E. (2000) "Technology Refreshment Strategy and Plan for Application in Military Systems – A How to Systems development Process and Linkage with CAIV" *IEEE Conference Proceedings* pp.729-736. Rickman, Dale M. (2001) "A New Process For Requirements Understanding" *IEEE DASC 2001 Conference Proceedings,* 4.D: 1-4. "Target Costing Best Practices Survey" Retrieved October 3, 2004 from http://www.cam-i.org/TC/survey.html Sakurai, M (1989) "Target Costing and How to use it" *Journal of Cost Management,* (Summer):39-50.

Table 13: Finished System Attributes and References

Finished System Attributes Survey Questions	**References**
Finished System Information: ❑ Cost? (development, maintenance, operation, profit) ❑ Time? (development, life duration) ❑ Customer Satisfaction/ Expectations? ❑ System Performance?	Anasari, Shahid L., and Bell, Jan E. (1997) *Target Costing : The Next Frontier in Strategic Cost Management*. Chicago, IL: Irwin Professional Publishing Bahill, Dean, Sage, Rouse (1999) *Handbook of Systems Engineering and Management*. Hoboken, NJ: John Wiley & Sons Blanchard, Benjamin. (2004) *Systems Engineering Management.* Hoboken, NJ: John Wiley & Sons Buede, Dennis (2000) *The Engineering Design of Systems (Models and Methods)*. Hoboken, NJ: John Wiley & Sons "DoD Defense Link home page" Retrieved September 5, 2004 from http://www.defenselink.mil/search/ Rush, Dr. Benjamin (1997) "Cost as an Independent Variable: Concepts and Risks" *Acquisition Review Quarterly,* (Spring): 161-172. "Target Costing Best Practices Survey" Retrieved October 3, 2004 from http://www.cam-i.org/TC/survey.html

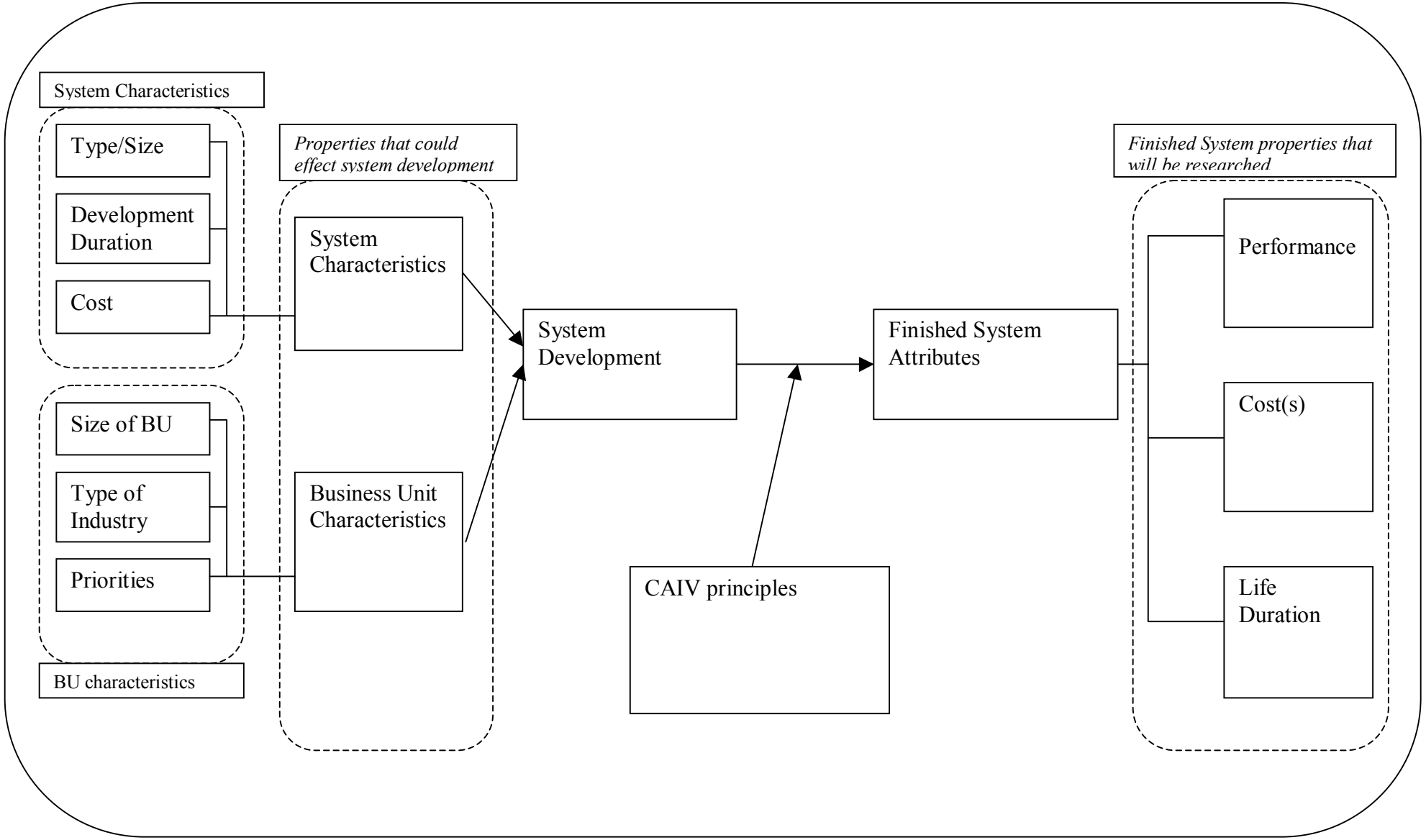

Figure 2: Research Model (CAIV's Effect on Finished Systems)

CHAPTER IV

RESEARCH METHODOLOGY

Prior research failed to address the research questions and therefore exploratory research was conducted via a pilot study. In this study, field interviews were used as well as surveys emailed to participants. The field interviews were used as a basis to verify that the survey's meaning was indeed clear and concise. The interview guidelines suggested by Fowler (2001) were followed for compiling the questions. The questions involved were a combination of structured (the questionnaire discussed in Ch 3) and unstructured questions (Trochim, 2001). The structured questions were used to get direct measures and answers from the respondent. The unstructured questions were used to find other issues involving CAIV, and also to get first hand responses from people who use CAIV.

The surveys sent out via email were sent to experts with whom it was not possible to meet with face to face. These surveys were sent to locations in which the researcher did not perform any field interviews. The same survey that was used in the field interviews was emailed to participants. The reason more experts were used was to further validate the instrument and also expand knowledge in the field.

Sample

Cooperation for the field interviews was solicited from organizations involved in using CAIV. For respondent to be used in the study they had to have been part of a project in which CAIV was used or have vision into a project in which CAIV was used and have seen the results of its use.

For the field interviews the researcher was able to conduct three at a military base. Two of the respondents were able to meet the criteria for inclusion and were willing to spend the time required to participate. The reason that only two out of the three can be included is due to the fact that the third was a test and evaluation engineer and had no perspective of CAIV's use or effect.

The surveys that were emailed out were sent to two other military development centers. Via survey the researcher was able to solicit participation from six other individuals who met the criteria for inclusion. The total sample consisted of eight responses from individuals

involved in governmental system development at three separate locations.

Format

The field interviews followed the format of the survey (see Appendix B). In the field interviews the respondents were taken through the survey question by question. The reason this was done was to ensure the clarity of the questions and answers.

The first part of the interview or survey asked the respondents general questions about their frame of reference for answering the questions. This part of the survey investigated what kind of system they were referring too in their responses. It also asked questions about the system. For example: how much money was committed to it, time it spent in development, and number of people involved in its development. The next part investigated the type of business unit that each respondent was a part of. After the respondent answered the questions about the system and business unit they were then presented with a question that asked them if they used each of CAIV's main principles. After this question they were asked whether or not they used CAIV on the system that was identified. If a respondent answered no, then they were asked to why they did not use CAIV. If a yes was given they were then asked questions about CAIV's implementation and also its affects on systems. At the end of the survey each respondent was presented with an open-ended question to further elaborate on CAIV's successes or failures.

CHAPTER V

RESULTS

The results from the interviews and the survey are presented in the following order: (to view the results for each question see Appendix A)

1) System characteristics;
2) Business unit characteristics;
3) CAIV's use and implementation
4) Interview Themes.

System Characteristics

For the purposes of this study it was important to identify the characteristics of the system that each respondent would be referring to in their answers. From the interviews and the surveys, the overwhelming response was that a current system was being referred to. The only difference was a response in which the respondent was referring to a life extension of a legacy system for the purposes of the survey.

The systems that were being referred to spent anywhere from five to twenty-five plus years in development (from concept to production) with an average development time of just over twelve years. These systems were expected to be operational for ten to twenty-five plus years with an average operational time of over twenty-one years. Hundreds of people were involved in the development of these systems; the respondents indicated that fifty people to two thousand people were involved in the development of these systems. Finally, the systems being referred to initially had anywhere from twenty-five million to over one hundred million dollars committed to them. The responses showed that these systems were fairly large systems that required extensive time and money to enable them to reach operation in the field.

Business Unit Characteristics

The characteristics of the business unit in which each respondent worked were also identified by the interviews and survey. The respondents all answered that they worked in the Aerospace & Defense industry for the Government or a Government Contractor. The respondents were split on their functional area, half being in engineering and the other half

being in program management. The business units in which each respondent worked employed between fifty and five thousand people.

After providing an overview of what type of industry each respondent worked in, the respondents identified actions that were perceived as important in meeting competitive threats. The responses revealed that speed of delivery and lowest cost systems were the most important aspects to each business unit. The next most important components to meeting competitive threats that the respondents identified were a performance leader and producing long lasting reliable systems.

CAIV's Use and Implementation

Once the demographic information for the respondents had been established it was important to ascertain information regarding their use of CAIV and how CAIV was implemented at the organization. To first establish if the respondents were actually using CAIV, question number one in Section 3 asked the respondents to rate how important each of the main characteristics of CAIV were to their business unit. The respondents, with the exception of one, indicated that every characteristic was indeed important to their business unit. The one exception stated that a focus on cost reduction throughout the life cycle was not important (his responses were included with the others because he said his business unit used CAIV). A lack of importance placed on this principle could result in future problems for the respondent's systems. The problems that would result due to a lack of focus here are related to long-term system cost. If there is no focus on cost reduction throughout the life cycle of a system, then systems can incur many costs that were not initially anticipated and cause the operating system to go over budget. If the system goes over budget then cost will have to be cut elsewhere and the repercussions could lead to failure in other areas.

Once it was determined that the respondents used the principles of CAIV, they were asked whether or not they used CAIV based on the definition of CAIV. The overwhelming response to this question was that all but one used CAIV. The respondent that did not use CAIV specifically said that he had vision into a project in which CAIV was used and therefore could complete the rest of the survey. The respondents were then asked how CAIV had been implemented at their business unit. In response they said that they attended training, were given documentation on how to implement CAIV, or used a combination of the two. The answers presented here show that CAIV is used, its principles are important to the people who use

CAIV, and the people using CAIV were properly trained or provided with information regarding how to implement CAIV. Establishing these criteria is critical to the rest of the survey because without them the responses for the rest of the survey would be unreliable.

After establishing that CAIV was indeed being used and used properly, the survey then investigated why CAIV was being used, how long CAIV had been used, and how deep in the organization it was being used. The first question that needed to be answered after determining that CAIV was being used is why it is being used. The respondents were posed with this question and the overwhelming result was that CAIV's use was a federal mandate. Respondents were then asked how long CAIV had been used at their business unit and the majority of the respondents had been using CAIV for more than five years. The least amount of time that CAIV had been used in any of the respondent's business units was three to four years. These answers agreed with the answers previously given regarding CAIV being a well-established practice in the respondents' business units. Knowing now that CAIV was being used because it was required and it had been used for at least three years, the survey then asked on how many levels of the organization CAIV was being used. The answer to this was split with half using CAIV throughout their organizations and the other half using CAIV only in some business units and projects.

The next portion of the survey attempted to determine how the respondents' business units interacted with the suppliers they used. The information that was recorded from the question was that the respondents' business units set the cost for the system being produced. This indicated that they only used suppliers that would meet the allocated cost for what was being supplied. If the supplier was unable to meet the cost, the supplier was simply not used.

CAIV's Possible Effects

To investigate whether or not CAIV was affecting the systems it was being used on a series of statements relating to how CAIV affected system attributes and the respondents rated the statements on a scale of "-5" to "5". A rating of "-5" indicated that the use of CAIV decreased the aspect in question and a rating of "5" indicated that CAIV increased the aspect in question. For example, the respondent was given the statement "Cost of system before manufacturing" and if CAIV's use increased the cost, the respondent would rate the statement with a positive number depending on how much of an increase CAIV caused and if there was a decrease the same was done with the negative numbers. The responses from all of the surveys

were averaged to get an average response for each statement (standard deviation, median, and range were taken as well and can be seen in Appendix A).

CAIV's use affected some system statements negatively and some positively. First the system statements in which CAIV had a positive effect will be discussed. The statements that revealed a positive result of using CAIV all were related to cost. The first area in which the respondents showed a positive effect of CAIV is the cost of system before manufacturing. The respondents indicated that there was a slight reduction in the cost before manufacturing when CAIV was used. The cost of purchased materials was also reduced when CAIV was used. The other statements that showed CAIV having a positive result were for projected costs. The statements were: projected manufacturing costs, projected maintenance costs, and projected operating costs. The average response for all of these statements indicated a slight decrease in the costs for each one.

CAIV affected the other system statements in a negative way. The first area in which CAIV had a negative effect was time. The respondents indicated that the time required for system introduction increased when CAIV was used. On a related topic the number of design changes increased when CAIV was used as well. The next main area in which CAIV's use had a negative effect was in the area of the customer. The responses in regard to system features that customers value showed a decrease as did the expectations that customers had for the system. The answers given in association with overall system performance and profitability showed the largest decrease of any of the statements. Overall system profitability had no positive responses and overall system performance had only one. The last area in which the use of CAIV had negative responses was in the area of the cost of owning the system throughout its lifecycle and also the usable system life. The answers given showed a increase in the cost of owning the system throughout its life and a decrease in the usable system life of the system.

After responses in regards to how CAIV's use had affected the system on which it was used, the respondents were asked another series of questions about how different areas of the organization perceived the success of CAIV. The answers provided indicated that most groups in the organization perceived CAIV as at least somewhat successful. However, in the groups of design engineering, operations, industrial engineering, and quality there was at least one response indicating that these groups did not think that CAIV was successful. Design engineering was the group in which there was the greatest perceived lack of success followed closely by industrial engineering.

Themes from Average Responses

From the previous section there are overarching themes that have been identified from the interviews and the surveys. The first themes that will presented will be from the average responses (see Table 14).

The first theme that needs to be looked at is that the respondents on average answered that the use of CAIV caused the cost to decrease. The reason that this would need to be looked at closer is the due to the fact that CAIV sets the cost of a system. It is possible that CAIV's use reduced cost, but why it reduced cost needs to researched further. It is possible that CAIV reduced cost because it is an effective way to develop systems or it could be because CAIV allows less money to be used for the system in general. There could be other explanations for this trend as well.

Another important theme that was identified from the averaged responses was that when CAIV was used there was a decrease in the expectations of the customer and also in the features that the customer valued. Customers are usually the most important part of a system development. If the customer is not satisfied with the job that is done then it is quite possible that the customer will find someone else to develop their next system. It is interesting that CAIV's use resulted in decreased expectations for the system. The customer's decreased expectations could mean that the customer does not think that using CAIV will help the system being developed. Another reason for decreased expectations could be that the customer limits the money that the developer can spend and because of this does not expect as much from them. Decreased features and functions that customers value is a problem that should be addressed for any developer. If CAIV is causing systems to be developed without features and functions that the customer will value then its use in general needs to be addressed.

Along the same lines of decreased functions and features that customers value is another theme that was identified. The theme is a decrease in overall system performance and profitability when CAIV is used. A decrease in overall performance is an area that has to be considered when developing a new system. If it is not important for the system to have a very high level of performance or if performance is not important then its use could be permitted. However, if the system being developed is a system in which a lack of performance could result in people's lives being lost, for instance, then it should be evaluated as to whether it is the proper way to develop the system. Overall profitability decreasing is also an area that needs to be addressed. It is important for any business or organization to be able to make enough money

to stay in business. If using CAIV could be shown to interfere with this overarching goal of making profits then its use should come into question.

The next theme is how CAIV affects the cost of owning a system throughout its life and the duration of a systems usable life. The average response from the survey showed an increase in the cost of owning a system throughout its life. If using CAIV results in cost increasing in the long term then its use in the here and now should be evaluated. The use may save short term money but if the long term costs are escalating it may not be worth using. To identify this further the amount of increase in the long term needs to be compared to how much is saved in the short term to determine if the use of CAIV is warranted. The usable system life is critical for any system, especially if billions of dollars are committed to the system. If extreme amounts of time and money are committed to a system, and the method for development shortens the amount of time the system will be usable, then the development method needs to be addressed.

The averaged responses also indicated that there was an increased amount of time needed before system introduction and also in the amount of design changes. The fact that the responses indicated this is quite interesting. The reason is two fold, because it could be viewed as a negative or a positive result. If it is viewed as negative then it is because schedule is important and the use of CAIV is elongating the time needed for introduction and also the number of design changes. However, if viewed as a positive thing it could mean that the development team is taking more time to ensure that the best design is used for the system. Ensuring that the best design is used is a very positive thing for any system, but if it comes at the expense of the system being behind on schedule then it may be viewed as a negative effect.

The last theme identified regards the perceived success of CAIV by different groups in the organization. Questions were asked about several different groups in each organization. However, the groups that were identified as viewing the use of CAIV as "not successful" were the Engineering group, Operations/Manufacturing, and Quality group. Further attention should be paid to this trend, the Engineering and the Quality group especially. If the Engineering groups think that there are better ways to develop systems, then their input should be utilized since they are the ones that actually have to develop the design even though they are not totally responsible. The other group that is the most interesting is Quality. If a Quality group thinks that using CAIV reduces quality of systems being developed, then it should be explored as to why. There may be reason that both groups have that could be used to improve CAIV in general.

Other Response Themes

From the field interviews two other interesting themes were made apparent by the interviewees. The first theme of note was from a respondent whose information was not used for the average responses. His information was not used because his business unit did not used CAIV and he had no knowledge of CAIV. He said, "CAIV is not suitable for the type of work we do." However, what was interesting about this was when he was asked about the use of CAIV's principles in his business unit he answered that one principle was moderately important to his business unit and that the rest of the principles were very important.

The other truly interesting theme from the interview came from a respondent who was able to see CAIV used poorly and the results of this action. When his business unit used CAIV he said, "we did not set firm requirements or use the systems engineering process, and as a result we had to make changes." Every time changes were made the respondent said the cost of the system went up. The end result of this problem was that the importance of cost was lost and the focus was shifted to meeting the performance requirements. The respondent said, "if the performance levels had been firmly set in the beginning of the process and the systems engineering process was followed the system may have come in at the cost specified, but this did not happen and as a result the system ended up over budget." In order for CAIV to have success all of its principles need to be followed not just some of them. When there is no importance placed on one of the principles it could result in the undoing of the entire cost cutting initiative, and have negative results as seen in this case.

In other responses some positive and negative feedback was given for CAIV. The positive feedback included these quotes from the respondents: "CAIV helps with design tradeoffs and helps bring the focus to cost (in the past cost was not really considered) which is important"; another respondent said, "CAIV helped our business unit to better estimate the overall cost of the system and using CAIV we were able to bring the project under cost and deliver more".

However, there was also some negative feedback as well. The main point of the negative feedback is what one respondent said, " The entire concept of cost as an independent variable is fatally flawed. Cost is a dependent function like performance and all other system attributes. Usually, any major CAIV design/production change involves some aspect of reducing performance and/or reliability." However, sometimes nothing can be compromised but the amount of money spent due to importance of other attributes. For such cases CAIV may not

be the appropriate tool in which to design the system.

These themes and the themes from the averaged responses above were used to generate several propositions regarding the use of CAIV and its effect on finished system attributes. The first of which is: There is a relationship between the proper use of CAIV and the costs associated with a system. These costs could include development, procuring, manufacturing, operating, maintaining, profits, and long-term life costs. Using CAIV to develop a system could result in increasing or decreasing any of the costs associated with a system.

The next proposition is: There is a relationship between the proper use of CAIV and the overall performance levels of a system. The use of CAIV may increase or decrease the performance levels a system is capable of.

The third proposition is: There is a relationship between the proper use of CAIV and time associated with a system. The times associated with a system could include development time, usable system life, time required for introduction, manufacturing time, operating time, and other system related times. The use of CAIV could increase or decrease these times.

The final proposition is: There is a relationship between the proper use of CAIV and customer desires. Customer desires include aspects such as features, functions, expectations and others. CAIV could potentially affect these aspects. Its effect needs to be found out because the Government is requiring CAIV and the Government is in many cases the customer for these systems.

Table 14: Themes from Average Responses

Themes from Average Responses
1.Decrease in development and projected costs
2.Decrease in customer expectations and valued features and functions
3.Decrease in overall profitability and overall performance
4.Increase in cost of owning a system throughout its life
5.Decrease in usable system life (how long the system will be functional in the field)
6.Increase in time before system introduction and design changes
7.Engineering, Quality, and Operations only groups to view CAIV as not successful

CHAPTER VI

DISCUSSION AND CONCLUSION

The exploratory research reported in the previous chapter was done to determine if there is a need for research regarding CAIV and systems. The research that was performed resulted in qualitative information. This chapter will discuss the implications of the themes discovered in the research, and present suggestions for further research, limitations of the study and will summarize the thesis.

The goals of the thesis were to: 1) validate an instrument (the survey); 2) determine what affects CAIV could have on finished systems; 3) identify areas in which research is needed regarding the use of CAIV in system development. The literature review was conducted to generate the items used for questions in the survey (Churchill, 1979). Qualitative information was then ascertained from the interviews and completed surveys and from this information, themes for possible research were identified (see Results Chapter).

In general the instrument was able to provide the qualitative information desired about CAIV and its affects on systems. However, one of the questions was not as effective as intended. The majority of the respondents did not answer question number three about why CAIV was not implemented or if it was implemented barriers to implementing CAIV. It seems that this question was not necessary. In the government or government contracting industry CAIV is required or it is not. More business units need to be sampled to determine if there are business units that use CAIV that are not required to. For the sample in this case the question was not necessary because everyone using CAIV was required to. The question could be included for private sector companies that use CAIV because it would apply more to that case, but if the survey is only given to public sector business units it is unnecessary. The only other changes needed in the survey is to expand the amount of choices for the amount of money initially committed and for effects CAIV may have caused. The amount of money initially committed was kept low to find out if systems that did not cost billions were using CAIV as well (systems in which CAIV was not required by DoD Reg 5000.2.R). However, to send the survey to more business units it would be interesting to find out if systems that had billions committed to them and are required to use CAIV are using it. Adding more cost initially committed options would give the researcher a better idea of which systems were truly using CAIV. As far as the

question regarding effects CAIV may have caused further research should add other effects depending on what they are trying to find out. Added effects could be made more specific to the overall goals of further research. These changes would result in better information for the researcher. Even without these changes the survey was able to uncover some interesting themes.

The themes that were found in the qualitative information from the survey lead the researcher to realize that there is room and need for research in this area. The government requires CAIV to be used on major projects that have billions of dollars committed to them (DoD, 2001). The result of using CAIV on these projects of this magnitude needs to be uncovered before the use of the costing system is continued. The reason for this is beginning to be uncovered by the research in this thesis. The research here suggests that CAIV could possibly affect many different system attributes. These attributes are everything from cost to schedule to performance. In some cases here the costs associated with a system went up when CAIV was used. This alone needs to be investigated further to determine if this effect is really a result of CAIV's use. If using a costing system designed to reduced costs results in cost going up then it is clearly not doing what it is designed to do and the reason why should be uncovered. Information from this study indicates that on average cases performance levels were decreased when CAIV was used. If performance is not an important attribute to the system this may be acceptable. However, many of the systems that the Government and Governmental Contractors produce have the fate of individuals and a nation as a whole on their shoulders.

Reducing the performance of such systems could have dire results for many people, and if in fact CAIV does reduce performance levels the amount of reduction needs to be revealed. People using CAIV need to make sure that the reduction in performance does not reduce performance to a level in which is unacceptable.

The information herein also suggests that time needed for system introduction was increased. Whether this is a positive or negative factor needs to be ascertained. In some cases it could be positive and others it could be very negative. The reason it could be positive is it could indicate that more time is being spent on the development and due to this a better system may be produced. The negative side is that it takes longer to get to production and therefore longer to get to the customer.

Another area that CAIV may have had a negative impact is on the perception of success of the quality and engineering groups. Why these groups feel that CAIV was not successful needs to be inquired into. The success of the system does not rest on the perception of

success of these groups, but if they do not think that the systems being produced with CAIV are successful it could be important why they think this. It is possible that major improvements could be made in CAIV with the help of these groups. The last major theme that was produced from the research was the success of CAIV. The cases in which CAIV was used successfully and the system attributes were all affected in positive ways. These cases need to be further researched to find out what these groups did that allowed them to have success where others did not.

Although this study was able to uncover many possible themes for further research it is primarily a starting point. The study was able to find out some interesting qualitative information, but that is primarily all it is. One limitation of the study is that some possible effects of using CAIV were identified, but no respondent suggested any suggested or was asked why they thought these effects were happening. The sample size for the study was adequate for what it was trying to accomplish at best. The averaged responses were able to identify themes, but the standard deviations leave much to be desired. For further research more steps need to be taken to ensure that CAIV is the reason for the effects seen in the systems. Without further verifying that CAIV is the behind the changes then any quantitative results will come into question. However, the present study was able to verify that the instrument produced the desired information and also was able to uncover interesting qualitative information. This study should be viewed as exploratory research and as a pre test for a survey. The exploratory research resulted in the fact that there is plenty of room for research in this area and the pre test resulted in a validated survey. Further research needs to be done in each of the themes identified by this study to find out if it is isolated cases in which these things happen or if it happens on a larger scale. Without further research to verify the use of CAIV on major systems the government may not know whether or not it is hurting itself by requiring the use of this costing system.

APPENDIX A: SURVEY RESULTS

Section 1. System Information

1. For the purposes of this survey the "system" you are referring to is:

n	Percent	Answers
6	85%	A current system
1	15%	Other: a life extension
7	100%	Totals

2. How long did it take your business unit to create the system, from the development of the system concept to releasing of the system for production?

n	Percent	Answers
2	28%	5-6 years
2	28%	9-10 years
1	14%	10-15 years
1	14%	15-20 years
1	14%	25+ years
7	100%	Totals

3. How many people were involved in the development of this system?

n	Percent	Answers
4	57%	250 or less
2	28%	501-1000
1	14%	1001-2000
7	100%	Totals

4. How long is/was the system expected to be operational?

n	Percent	Answers
3	42%	25+ years
2	28%	20-25 years
1	14%	15-20 years
1	14%	10-15 years
7	100%	Totals

5. How frequently did you modify or enhance the system, and how frequently did you do a major redesign of the system before its release to production?

n	Percent	Answers for Modify/Enhance
3	**42%**	6 months or less
2	**28%**	3 to 5 years
1	**14%**	5 to 7 years
1	**14%**	2 to 3 years
7	**100%**	**Totals**

n	Percent	Answers for Major Redesign
3	**42%**	7 years or more
1	**14%**	3 to 5 years
1	**14%**	2 to 3 years
1	**14%**	Never
6	**85%**	**Totals**

6. The amount of money initially committed to the system is/was (please give an estimate if you do not know exactly)?

n	Percent	Answers
4	**57%**	over $100,000,000
2	**28%**	$25,000,000-$50,000,000
1	**14%**	$50,000,000-$100,000,000
7	**100%**	**Totals**

Section 2. Business Unit Information

1. What is the industry group for the primary products/services of your business unit?

n	Percent	Answers
7	100%	Aerospace & Defense
7	100%	Totals

2. What best characterizes your business organization?

n	Percent	Answers
4	57%	Government
3	42%	Government Contractor
7	100%	Totals

3. Your functional area:

n	Percent	Answers
4	57%	Engineering
3	42%	Program Management
7	100%	Totals

4. In this survey, we use the term "business unit" to capture the organizational perspective from which you are answering the questions. Please tell us how we should interpret the business unit in your case. I am completing this survey from the perspective of:

n	Percent	Answers
5	71%	A Government Project or a Program
1	14%	A Single Facility/Operation
1	14%	Other: (an RDEC)
7	100%	Totals

5. How many people does your business unit employ?

n	Percent	Answers
3	42%	250 or less people
2	28%	Over 5000 people
1	14%	1001-2000 people
1	14%	2001-5000 people
6	85%	Totals

6. How important to your business unit are each of the following actions in meeting competitive threats. Please assign equal weight to two items only if you feel they are equally important to your business unit. (1 being not important to 5 being very important)

Statements	1	2	3	4	5	Totals
Beating competitors to the market place with new systems						
Stats	*Mean = 2.57; Median = 2; Range = 5; St Dev = 1.71*					
n	3	1	0	2	1	7
Percent	42%	14%	0	28%	14%	100%
Providing superior service/support to customers						
Stats	*Mean = 3.71; Median = 4; Range = 3; St Dev = 1.38*					
n	0	2	1	1	3	7
Percent	0	28%	14%	14%	42%	100%
Guaranteeing speedy delivery of systems						
Stats	*Mean = 3; Median = 4; Range = 2; St Dev = .69*					
n	0	0	2	4	1	7
Percent	0	0	28%	57%	14%	100%
Providing more and better features than others						
Stats	*Mean = 3; Median = 3; Range = 4; St Dev = 1.32*					
n	1	0	3	1	1	6
Percent	14%	0	42%	14%	14%	85%
Providing more reliable, longer-lasting systems						
Stats	*Mean = 1.85; Median = 5; Range = 4; St Dev = 1.46*					
n	1	0	0	2	4	7
Percent	14%	0	0	28%	57%	100%
Being cost leaders and providing the lowest cost systems						
Stats	*Mean = 3.85; Median = 4; Range = 3; St Dev = .89*					
n	0	1	0	5	1	7
Percent	0	14%	0	71%	14%	100%

Being the performance leader						
Stats	*Mean =3.85; Median = 4; Range = 4; St Dev = 1.46*					
n	1	0	1	2	3	7
Percent	14%	0	14%	28%	42%	100%
Being the sole supplier of a certain technology						
Stats	*Mean = 2.67; Median = 4; Range = 3; St Dev = 1.50*					
n	2	1	0	3	0	6
Percent	28%	14%	0	42%	0	85%

Additional Comments: Government, despite incentives to emulate business, is not business. Accordingly, the business metaphors are often not very accurate in relating government, especially Defense, situations. Since the DoD basically has three "labs" developing missiles, one for each service, and the environmental and mission requirements are so different in each service, traditional "competition" is almost completely absent. This is even more the case with helicopters where basic development is vested in one service with responsibility for assuring that the designs are adaptable to other service specifics. Overall, the arena of competition is budgetary in nature. That is, there is competition over which systems (programs) are funded.

Section 4: Cost as an Independent Variable (CAIV)

1. Indicate the extent to which the following statements capture your business unit's system development process: (1 being 'Not at All' to 5 being 'Extensive')

Statements	1	2	3	4	5	Totals
The overall cost of the system was set before the system is designed						
Stats	*Mean =3.57; Median = 4; Range = 3; St Dev = 1.11*					
n	0	1	2	2	2	7
Percent	0	14%	28%	28%	28%	100%
Tradeoffs were used to reduce the cost of the system						
Stats	*Mean = 4; Median = 4; Range = 2; St Dev = .89*					
n	0	0	2	3	2	7
Percent	0	0	28%	42%	28%	100%
Requirements for systems are capabilities based (i.e. define what performance levels the system must meet)						
Stats	*Mean = 4.43; Median = 5; Range = 3; St Dev = 1.13*					
n	0	1	0	1	5	7
Percent	0	14%	0	14%	71%	100%
People from different departments participate in system development						
Stats	*Mean = 4.57; Median = 5; Range = 1; St Dev = .53*					
n	0	0	0	3	4	7
Percent	0	0	0	42%	57%	100%
There was a focus on cost reduction throughout the systems life cycle						
Stats	*Mean = 3.71; Median = 4; Range = 4; St Dev = 1.49*					
n	1	0	2	1	3	7
Percent	14%	0	28%	14%	42%	100%

2. Are you currently using Cost as an Independent Variable (CAIV) at your business unit? In answering this question please consider the following definition of CAIV:

n	Percent	Answers
4	57%	CAIV is well established in our business unit.
1	14%	Our business unit recently started implementing CAIV
1	14%	Our business unit uses CAIV or many of its methods under a different name. The name used is: Name for CAIV: CAIV but with rationality
1	14%	Other: Vision into project in which CAIV was used, but not used at his business unit
7	100%	Totals

3. If your business unit has not adopted CAIV, to what extent did the following factors influence your decision not to implement CAIV? If you have adopted CAIV, to what extent were the following factors Barriers to improving CAIV in your business unit?

Statements	1	2	3	4	5	Totals
Lack of familiarity with CAIV						
n	0	0	3	0	0	3
Percent	0	0	42%	0	0	42%
Perception that CAIV is a passing fad						
n	0	1	1	1	0	3
Percent	0	14%	14%	14%	0	42%
Faced with more pressing business problems						
n	1	1	1	0	0	3
Percent	14%	14%	14%	0	0	42%
Did not get top management sponsorship/support						
n	1	1	1	0	0	3
Percent	14%	14%	14%	0	0	42%
CAIV is not relevant for our kind of business						
n	1	1	1	0	0	3
Percent	14%	14%	14%	0	0	42%
Cross-functional cooperation is difficult to get						
n	0	0	1	2	0	3
Percent	0	0	14%	28%	0	42%
People are unwilling to change						
n	0	0	1	2	0	3
Percent	0	0	14%	28%	0	42%
Did not get any results or benefits from use of CAIV						
n	0	2	1	0	0	3
Percent	0	28%	14%	0	0	42%
Lack of education/training about CAIV						
n	0	0	3	0	0	3
Percent	0	0	42%	0	0	42%

No reason to change our pricing methods						
n	**1**	**2**	**0**	**0**	**0**	**3**
Percent	**14%**	**28%**	**0**	**0**	**0**	**42%**
Missing cost targets is viewed negatively						
n	**0**	**0**	**1**	**2**	**0**	**3**
Percent	**0**	**0**	**14%**	**28%**	**0**	**42%**
No rewards for achieving cost targets						
n	**0**	**0**	**2**	**0**	**1**	**3**
Percent	**0**	**0**	**28%**	**0**	**14%**	**42%**
Other initiatives are more important						
n	**1**	**0**	**1**	**1**	**0**	**3**
Percent	**14%**	**0**	**14%**	**14%**	**0**	**42%**
Do not have resources to implement CAIV						
n	**2**	**0**	**1**	**0**	**0**	**3**
Percent	**28%**	**0**	**14%**	**0**	**0**	**42%**
Our business unit already had a good understanding of our costs						
n	**0**	**1**	**2**	**0**	**0**	**3**
Percent	**0**	**14%**	**28%**	**0**	**0**	**42%**
The accounting/information system does not support CAIV						
n	**0**	**2**	**0**	**1**	**0**	**3**
Percent	**0**	**28%**	**0**	**14%**	**0**	**42%**
Our business unit was not able to identify any company that had success using CAIV						
n	**2**	**1**	**0**	**0**	**0**	**3**
Percent	**28%**	**14%**	**0**	**0**	**0**	**42%**
Our business unit lacks systematic methods for incorporating customer cost input						
n	**2**	**1**	**0**	**0**	**0**	**3**
Percent	**28%**	**14%**	**0**	**0**	**0**	**42%**

4. How long has CAIV been used at your business unit?

n	Percent	Answers
3	**42%**	Over 10 years
2	**28%**	Over 5 years
1	**14%**	4-5 years
1	**14%**	3-4 years
7	**100%**	**Totals**

5. The decision to adopt CAIV was made by:

n	Percent	Answers
3	42%	Other: DoD
2	28%	A Government Project or a Program
1	14%	The Entire Company
7	100%	Totals

6. What is the depth of CAIV implementation in your organization?

n	Percent	Answers
4	57%	Throughout the corporation
2	28%	Only at some business units
1	14%	Other: a particular project
7	100%	Totals

7. When our business unit implemented CAIV: (6 out of 7 answered question; but some respondents gave multiple answers)

n	Percent	Answers
5	71%	Our business unit attended training
1	14%	Other: We reviewed the definition and then developed techniques, practices and policies of how to implement. These have been refined based on observation of other organization's implementation.
1	14%	Our business unit was given documentation about CAIV
6	85%	Totals

8. Our CAIV system: (NA=not applicable to your business unit)

Statements	Yes	No	NA	Totals
Mandates cost targets for all suppliers				
n	1	4	2	7
Percent	14%	57%	28%	100%
Lets suppliers develop their own cost targets				
n	5	1	1	7
Percent	71%	14%	14%	100%
Assigns cost targets only to affiliated companies				
n	0	2	3	5
Percent	0	28%	42%	71%

Assigns cost targets only for critical parts				
n	**1**	**3**	**1**	**5**
Percent	**14%**	**42%**	**14%**	**71%**
Assigns cost targets only for costly parts				
n	**1**	**3**	**1**	**5**
Percent	**14%**	**42%**	**14%**	**71%**
Assigns cost targets only to suppliers where our company is a major buyer				
n	**0**	**2**	**3**	**5**
Percent	**0**	**28%**	**42%**	**71%**

9. CAIV may have caused the following changes. If CAIV has significantly decreased system cost, you should circle –5. However, if it has caused cost to increase significantly you should circle 5:

Statements	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**Total**
Cost of system before manufacturing												
Stats	*Mean = -0.4; Median = -2; Range = 5; St Dev = 2.15*											
n	0	0	0	4	0	1	0	1	1	0	0	7
Percent	0	0	0	57%	0	14%	0	28%	14%	0	0	100%
Time required for system introduction												
Stats	*Mean = +0.7; Median = 0; Range = 3; St Dev = 1.25*											
n	0	0	0	0	1	3	0	3	0	0	0	7
Percent	0	0	0	0	14%	42%	0	42%	0	0	0	100%
System features and functions that customers value												
Stats	*Mean = -1.14; Median = 0; Range = 5; St Dev = 2.33*											
n	0	2	0	1	0	1	2	0	0	0	0	6
Percent	0	28%	0	14%	0	14%	28%	0	0	0	0	85%
Customer expectations for system												
Stats	*Mean = -1.28; Median = -2; Range = 6; St Dev = 2.50*											
n	0	2	0	2	1	0	1	0	1	0	0	7
Percent	0	28%	0	28%	14%	0	14%	0	14%	0	0	100%

Cost of purchased materials												
Stats	*Mean =-0.28; Median = 0; Range = 3; St Dev = 1.03*											
n	0	0	0	1	1	3	1	0	0	0	0	6
Percent	0	0	0	14%	14%	42%	14%	0	0	0	0	85%
Projected Manufacturing costs												
Stats	*Mean = -0.14; Median = 0; Range = 4; St Dev = 1.46*											
n	0	0	0	2	0	3	1	1	0	0	0	7
Percent	0	0	0	28%	0	42%	14%	14%	0	0	0	100%
Projected Maintenance costs												
Stats	*Mean = -.28; Median = 0; Range = 7; St Dev = 2.62*											
n	0	0	2	1	0	2	0	1	0	1	0	7
Percent	0	0	28%	14%	0	28%	0	14%	0	14%	0	100%
Projected Operating costs												
Stats	*Mean =-0.42; Median = -1; Range = 6; St Dev = 2.22*											
n	0	0	1	2	1	1	0	1	1	0	0	7
Percent	0	0	14%	28%	14%	14%	0	14%	14%	0	0	100%
Number of design changes after production begins												
Stats	*Mean = +0.5; Median = 0; Range = 8; St Dev = 3.05*											
n	0	0	1	1	0	2	0	0	1	1	1	7
Percent	0	0	14%	14%	0	28%	0	0	14%	14%	14%	100%
Overall system profitability												
Stats	*Mean = -1.71; Median = -2; Range = 5; St Dev = 2.51*											
n	2	0	0	1	0	2	0	0	0	0	0	5
Percent	28%	0	0	14%	0	28%	0	0	0	0	0	71%

Overall system performance												
Stats	*Mean = -1.57; Median = 0; Range = 7; St Dev = 2.76*											
n	2	0	1	0	0	3	0	1	0	0	0	7
Percent	28%	0	14%	0	0	42%	0	14%	0	0	0	100%
The cost of owning the system throughout its lifecycle												
Stats	*Mean = +0.71; Median = -1; Range = 8; St Dev = 3.49*											
n	0	0	1	2	1	0	0	0	1	0	2	7
Percent	0	0	14%	28%	14%	0	0	0	14%	0	28%	100%
Usable system life												
Stats	*Mean = -0.28; Median = 0; Range = -2; St Dev = .75*											
n	0	0	0	1	0	6	0	0	0	0	0	7
Percent	0	0	0	14%	0	85%	0	0	0	0	0	100%

Additional Comments: "CAIV has not help keep cost down, firm requirements were not set and due to this the cost of the system went well over budget"

10. How successful do the following groups regard your CAIV system? ((NA=not applicable to your business unit)

Statements	**Not Success**	**Somewhat**	**Moderate**	**General**	**Extreme**	**NA**	**Total**
Senior management							
n	**0**	**1**	**1**	**4**	**0**	**0**	**6**
Percent	**0**	**14%**	**14%**	**57%**	**0**	**0**	**85%**
Accounting/Finance							
n	**0**	**0**	**2**	**1**	**1**	**2**	**6**
Percent	**0**	**0**	**28%**	**14%**	**14%**	**28%**	**85%**
Design engineering							
n	**3**	**0**	**0**	**2**	**0**	**1**	**6**
Percent	**42%**	**0**	**0**	**28%**	**0**	**14%**	**85%**
Purchasing							
n	**0**	**1**	**1**	**0**	**1**	**3**	**6**
Percent	**0**	**14%**	**14%**	**0**	**14%**		**85%**

Operations/Manufacturing							
n	**1**	**2**	**0**	**1**	**0**	**2**	**6**
Percent	**14%**	**28%**	**0**	**14%**	**0**	**28%**	**85%**
Industrial engineering							
n	**2**	**1**	**2**	**0**	**0**	**1**	**6**
Percent	**28%**	**14%**	**28%**	**0**	**0**	**14%**	**85%**
Quality							
n	**1**	**3**	**0**	**1**	**0**	**1**	**6**
Percent	**14%**	**42%**	**0**	**14%**	**0**	**14%**	**85%**
Distribution							
n	**0**	**0**	**0**	**0**	**0**	**6**	**6**
Percent	**0**	**0**	**0**	**0**	**0**	**85%**	**85%**
Sales/Marketing							
n	**0**	**0**	**0**	**0**	**0**	**6**	**6**
Percent	**0**	**0**	**0**	**0**	**0**	**85%**	**85%**
Your Business Unit							
n	**0**	**1**	**2**	**1**	**1**	**1**	**6**
Percent	**0**	**14%**	**28%**	**14%**	**14%**	**14%**	**85%**

11. If CAIV is not already used throughout the organization will its use be extended to other business units? Why or why not?

-"already used throughout"

-"already used on major projects/programs"

12. Will your business unit use CAIV again? Why or why not?

-"CAIV is currently mandated, Choice is not an option"

-"Yes, Mandated"

-"Yes. It is required and it works"

-"Yes. It is a federal mandate"

_"Yes, DoD/US Army directed"

Please elaborate on the success/failures of CAIV in regards to your selected system:

-" Success: People realize that cost should be used like a "CI." We were able to bring the project under cost and deliver more because at each phase of the SE and LC we had established allocated cost based on system-level cost. In general we are doing much better in

estimating the overall cost of the system because of the CAIV.
Failure: Cannot think of any specific. Unless people are trained in CAIV, it could impact the use of alternatives/options analysis. Rather than selecting cost as a measuring criteria, people sometimes consider it as a barrier in doing them."

-"it helps with design trade-offs, in past cost not considered, this is changing, now we are working more with reliability"

-" The entire concept of cost as an independent variable is fatally flawed. Cost is a dependent function like performance and all other system attributes. Usually, any major CAIV design/production change involves some aspect of reducing performance and/or reliability. This is especially true on aircraft, where weight, performance and survivability drive the entire system design"

APPENDIX B: SURVEY

CAIV SURVEY

RESPONDANT INFORMATION

Company Name _____
Name of person completing survey _____
Title _____
Address _____
_____
Phone # _____ **e-mail** _____

I WOULD LIKE TO GET A REPORT OF THE STUDY'S RESULTS ❑

Section 1. System Information

For this survey consider the following definition:
System- a group of elements or components that work together to accomplish a common goal such a system can be physical objects and/or software. For example, landing gear, safety, wings, controls, computers, etc.. are the elements/components that make up the system of an airplane.

1. For the purposes of this survey the "system" you are referring to is: (check one)

- ❑ A current system
- ❑ A retired system
- ❑ An abandoned system
- ❑ A system that has yet to be introduced
- ❑ A system that has been produced before
- ❑ Other _____

2. How long did it take your business unit to create the system, from the development of the system concept to releasing of the system for production? (check one)

❑ Less than 1 yr.	❑ 5-6 yrs	❑ 10-15 yrs
❑ 1-2 yrs.	❑ 6-7 yrs	❑ 15-20 yrs
❑ 2-3 yrs.	❑ 7-8 yrs	❑ 20-25 yrs
❑ 3-4 yrs.	❑ 8-9 yrs	❑ 25+ yrs
❑ 4-5 yrs.	❑ 9-10 yrs	

3. How many people were involved in the development of this system? (check one)

- ❑ 250 or less
- ❑ 251-500
- ❑ 501-1000
- ❑ 1001-2000
- ❑ 2001-5000
- ❑ Over 5000

4. How long is/was the system expected to be operational? (check one)

- ❑ Less than 1 yr.
- ❑ 1-2 yrs.
- ❑ 2-3 yrs.
- ❑ 3-4 yrs.
- ❑ 4-5 yrs.
- ❑ 5-6 yrs
- ❑ 6-7 yrs
- ❑ 7-8 yrs
- ❑ 8-9 yrs
- ❑ 9-10 yrs
- ❑ 10-15 yrs
- ❑ 15-20 yrs
- ❑ 20-25 yrs
- ❑ 25+ yrs

5. How frequently did you modify or enhance the system, and how frequently did you do a major redesign of the system before its release to production?

	Modify/Enhance	**Major redesign**
6 months or less	❑	❑
6 to 12 months	❑	❑
1 to 2 years	❑	❑
2 to 3 years	❑	❑
3 to 5 years	❑	❑
5 to 7 years	❑	❑
7 years or more	❑	❑
Never	❑	❑

6. The amount of money initially committed to the system is/was (please give an estimate if you do not know exactly)? (check one)

- ❑ Less than $25,000
- ❑ $25,000-$50,000
- ❑ $50,000-$100,000
- ❑ $100,000-$250,000
- ❑ $250,000-$500,000
- ❑ $500,000-$1,000,000
- ❑ $1,000,000-$2,000,000
- ❑ $2,000,000-$5,000,000
- ❑ $5,000,000-$10,000,000
- ❑ $10,000,000-$25,000,000
- ❑ $25,000,000-$50,000,000
- ❑ $50,000,000-$100,000,000
- ❑ over $100,000,000

**If possible please list the name of the system you are referring to: **

_____

_____

_____

Section 2. Business Unit Information

1. What is the industry group for the primary products/services of your business unit? (check all that apply)

- ❑ Transportation Equip
- ❑ Electrical/Electronics
- ❑ Precision Equipment
- ❑ Aerospace & Defense
- ❑ Steel
- ❑ Machinery
- ❑ Textiles
- ❑ Food
- ❑ Chemicals
- ❑ Other_____
- ❑ Non-ferrous/metal
- ❑ Oil, Rubber, Glass
- ❑ Pulp & Paper
- ❑ Service

2. What best characterizes your business organization? (check one)

- ❑ Government Contractor
- ❑ Commercial Supplier
- ❑ Retail Wholesaler
- ❑ Other_____

3. Your functional area: (check one)

- ❑ Engineering
- ❑ Marketing
- ❑ Finance
- ❑ Purchasing
- ❑ Manufacturing
- ❑ Other _____

4. In this survey, we use the term "business unit" to capture the organizational perspective from which you are answering the questions. Please tell us how we should interpret the business unit in your case. I am completing this survey from the perspective of: (check one)

- ❑ A Single Department/Function Only
- ❑ A Single Facility/Operation
- ❑ A Government Project or a Program
- ❑ Multiple Departments
- ❑ Multiple Facilities
- ❑ A Commercial Product line
- ❑ A Division/Group
- ❑ The Entire Company
- ❑ Other _____

5. How many people does your business unit employ? (check one)

- ❑ 250 or less
- ❑ 251-500
- ❑ 501-1000
- ❑ 1001-2000
- ❑ 2001-5000
- ❑ Over 5000

6. How important to your business unit are each of the following actions in meeting competitive threats. Please assign equal weight to two items only if you feel they are equally important to your business unit. **(1 being not important to 5 being very important)**

	Not Important		Moderately		Very Important
Beating competitors to the market place with new systems	**1**	**2**	**3**	**4**	**5**
Providing superior service/support to customers	**1**	**2**	**3**	**4**	**5**
Guaranteeing speedy delivery of systems	**1**	**2**	**3**	**4**	**5**
Providing more and better features than others	**1**	**2**	**3**	**4**	**5**
Providing more reliable, longer-lasting systems	**1**	**2**	**3**	**4**	**5**
Being cost leaders and providing the lowest cost systems	**1**	**2**	**3**	**4**	**5**
Being the performance leader	**1**	**2**	**3**	**4**	**5**
Being the sole supplier of a certain technology	**1**	**2**	**3**	**4**	**5**

Other, please describe _____

_____

Section 3: Cost as an Independent Variable (CAIV)

1. Indicate the extent to which the following statements capture your business unit's system development process: (1 being 'Not at All' to 5 being 'Extensive')

	Not Important		Moderately		Very Important
The overall cost of the system was set before the system is designed	**1**	**2**	**3**	**4**	**5**
Tradeoffs were used to reduce the cost of the system	**1**	**2**	**3**	**4**	**5**
Requirements for systems are capabilities based (i.e. define what performance levels the system must meet)	**1**	**2**	**3**	**4**	**5**
People from different departments participate in system development	**1**	**2**	**3**	**4**	**5**
There was a focus on cost reduction throughout the systems life cycle	**1**	**2**	**3**	**4**	**5**

2. Are you currently using Cost as an Independent Variable (CAIV) at your business unit? In answering this question please consider the following definition of CAIV: (check one)

> **"…a process that helps arrive at cost objectives (including life-cycle costs) and helps the requirements community set performance objectives. The CAIV process shall be used to develop an acquisition strategy for acquiring and operating affordable DoD systems by setting aggressive, achievable cost objectives and managing achievement of these objectives. Cost objectives shall also be set to balance mission needs with projected out-year resources, taking into account anticipated process improvements in both DoD and defense industries."**
> **(DoD 5000.2.R, Section 3.3.4)**

❑ I am not sure.
❑ Our business unit never seriously considered implementing CAIV.
❑ Our business unit considered (or attempted) CAIV, but did not implement CAIV.
❑ Our business unit considered CAIV, but have not made a decision.
❑ Our business unit attempted CAIV but abandoned it.
❑ Our business unit are planning to implement CAIV in the future.
❑ Our business unit recently started implementing CAIV
❑ CAIV is well established in our business unit.
❑ Our business unit uses CAIV or many of its methods under a different name. The name used is: Name for CAIV _____

3. If your business unit has not adopted CAIV, to what extent did the following factors influence your decision not to implement CAIV? If you have adopted CAIV, to what extent were the following factors Barriers to improving CAIV in your business unit?

	Not Important		Moderately		Very Important
Lack of familiarity with CAIV	**1**	**2**	**3**	**4**	**5**
Perception that CAIV is a passing fad	**1**	**2**	**3**	**4**	**5**
Faced with more pressing business problems	**1**	**2**	**3**	**4**	**5**
Did not get top management sponsorship/support	**1**	**2**	**3**	**4**	**5**
CAIV is not relevant for our kind of business	**1**	**2**	**3**	**4**	**5**
Cross-functional cooperation is difficult to get	**1**	**2**	**3**	**4**	**5**
People are unwilling to change	**1**	**2**	**3**	**4**	**5**
Did not get any results or benefits from use of CAIV	**1**	**2**	**3**	**4**	**5**
Lack of education/training about CAIV	**1**	**2**	**3**	**4**	**5**
No reason to change our pricing methods	**1**	**2**	**3**	**4**	**5**
Missing cost targets is viewed negatively	**1**	**2**	**3**	**4**	**5**
No rewards for achieving cost targets	**1**	**2**	**3**	**4**	**5**
Other initiatives are more important	**1**	**2**	**3**	**4**	**5**
Do not have resources to implement CAIV	**1**	**2**	**3**	**4**	**5**
Our business unit already had a good understanding of our costs	**1**	**2**	**3**	**4**	**5**
The accounting/information system does not support CAIV	**1**	**2**	**3**	**4**	**5**
Our business unit was not able to identify any company that had success using CAIV	**1**	**2**	**3**	**4**	**5**
Our business unit lacks systematic methods for incorporating customer cost input	**1**	**2**	**3**	**4**	**5**

Other, please describe _____

_____

Stop Here If Your Business Unit Does Not Use CAIV, If You Do Please Continue

4. How long has CAIV been used at your business unit? (check one)

- ❑ 0-6 months
- ❑ 6-12 months
- ❑ 1-2 yrs.
- ❑ 2-3 yrs.
- ❑ 3-4 yrs.
- ❑ 4-5 yrs.
- ❑ Over 5 yrs.
- ❑ Over 10 yrs.

5. The decision to adopt CAIV was made by: (check one)

- ❑ A Single Department/Function Only
- ❑ A Government Project or a Program
- ❑ Multiple Facilities
- ❑ A Division/Group
- ❑ Other _____
- ❑ A Single Facility/Operation
- ❑ Multiple Departments
- ❑ A Commercial Product line
- ❑ The Entire Company

6. What is the depth of CAIV implementation in your organization? (check one)

- ❑ Throughout the corporation
- ❑ Only at some business units
- ❑ Only at our business unit
- ❑ Other _____
- ❑ Within a group or division
- ❑ Only for some products
- ❑ Only for my product line

7. When our business unit implemented CAIV: (check all that apply)

- ❑ Our business unit attended training
- ❑ Our business unit was given documentation about CAIV
- ❑ An outsider was brought in to implement CAIV
- ❑ One person attended training then trained the rest of the business unit
- ❑ Other_____

_____

_____

8. Our CAIV system: (NA=not applicable to your business unit)

	Yes	No	NA	
Mandates cost targets for all suppliers		❑	❑	❑
Lets suppliers develop their own cost targets		❑	❑	❑
Assigns cost targets only to affiliated companies		❑	❑	❑
Assigns cost targets only for critical parts		❑	❑	❑
Assigns cost targets only for costly parts		❑	❑	❑
Assigns cost targets only to suppliers where our company is a major buyer		❑	❑	❑

9. CAIV may have caused the following changes. For example, if CAIV has significantly decreased system cost, you should circle –5. However, if it has caused cost to increase significantly you should circle 5:

	Extremely Decreased					**No Effect**					**Extremely Increased**
Cost of system before manufacturing	-5	-4	-3	-2	-1	0	1	2	3	4	5
Time required for system introduction	-5	-4	-3	-2	-1	0	1	2	3	4	5
System features and functions that customers value	-5	-4	-3	-2	-1	0	1	2	3	4	5
Customer expectations for system	-5	-4	-3	-2	-1	0	1	2	3	4	5
Cost of purchased materials	-5	-4	-3	-2	-1	0	1	2	3	4	5
Projected Manufacturing costs	-5	-4	-3	-2	-1	0	1	2	3	4	5
Projected Maintenance costs	-5	-4	-3	-2	-1	0	1	2	3	4	5
Projected Operating costs	-5	-4	-3	-2	-1	0	1	2	3	4	5
Number of design changes after production begins	-5	-4	-3	-2	-1	0	1	2	3	4	5
Overall system profitability	-5	-4	-3	-2	-1	0	1	2	3	4	5
Overall system performance	-5	-4	-3	-2	-1	0	1	2	3	4	5
The cost of owning the system throughout its lifecycle	-5	-4	-3	-2	-1	0	1	2	3	4	5
Usable system life	-5	-4	-3	-2	-1	0	1	2	3	4	5

Other effects not listed above

_____

_____

_____

10. How successful do the following groups regard your CAIV system? ((NA=not applicable to your business unit)

	Not Successful		Somewhat	Moderately	Generally	Extremely Successful	NA
Senior management	❑	❑	❑	❑	❑	❑	
Accounting/Finance	❑	❑	❑	❑	❑	❑	
Design engineering	❑	❑	❑	❑	❑	❑	
Purchasing	❑	❑	❑	❑	❑	❑	
Operations/Manufacturing	❑	❑	❑	❑	❑	❑	
Industrial engineering	❑	❑	❑	❑	❑	❑	
Quality	❑	❑	❑	❑	❑	❑	
Distribution	❑	❑	❑	❑	❑	❑	
Sales/Marketing	❑	❑	❑	❑	❑	❑	
Your Business Unit	❑	❑	❑	❑	❑	❑	

11. If CAIV is not already used throughout the organization will its use be extended to other business units? Why or why not? _____

_____

_____

_____

_____

12. Will your business unit use CAIV again? Why or why not?_____

_____

_____

_____

_____

Please elaborate on the success/failures of CAIV in regards to your selected system:

_____

_____

_____

_____

_____

_____

_____

_____

BIBLIOGRAPHY

1. "2004 DoD Budget", *Overhaul and Maintenance,* 10(1:Jan/Feb 2004): 36

2. "Acquisition Community Connection home page" Retrieved September 5, 2004 from http://acc.dau.mil/simplify/ev_en.php?ID=1433_201&ID2=DO_TOPIC

3. "Army cancels Comanche Helicopter Program" Retrieved December 9, 2004 from http://www.govexec.com/dailyfed/0204/022304cdpm2.htm

4. "Defense Acquisition," DoDD 5000.1, March 15, 1996.

5. "DoD Defense Link home page" Retrieved September 5, 2004 from http://www.defenselink.mil/search/

6. "DoN Acquisition One Source Home page" Retrieved September 5, 2004 from http://www.abm.rda.hq.navy.mil/navyaos/content/view/full/128

7. "DoD spending bill includes nanotechnology funds" Retrieved December 9, 2004 from http://www.eetimes.com/at/news/showArticle.jhtml?articleID=25600219

8. "Take a Systematic Approach to Cost-Cutting" (1999) *American Banker,* 164(209:Oct 29): 6-7.

9. Albright, Tom, Funk, Wilfried and Hibbets, Aleecia R. (2003) "The competitive environment and strategy of target costing implementers: evidence from the field" *Journal of Managerial Issues,* 15(1:Spring 2003): 65-74.

10. Anasari, Shahid L., and Bell, Jan E. (1997) *Target Costing : The Next Frontier in Strategic Cost Management*. Chicago, IL: Irwin Professional Publishing

11. Bahill, Dean, Sage, Rouse (1999) *Handbook of Systems Engineering and Management*. Hoboken, NJ: John Wiley & Sons

12. Berry, E and Beckmann, EC. (n.d) *Systematic Literature Reviewing.* Retrieved October 15, 2004 from University of Leeds: http://www.comp.leeds.ac.uk/comir/people/eberry/sysrev/sysmenu.htm

13. Blanchard, Benjamin. (2004) *Systems Engineering Management.* Hoboken, NJ: John Wiley & Sons

14. Brausch, John M. (1994) "Beyond ABC: target costing for profit enhancement" *Management Accounting (USA)*, 76(5: Nov): 45-50.

15. Bruggeman, Werner and Everaert, Patricia (2002) "Cost Targets and time Pressure during new product Development" *International Journal of Operations & Production Management,* 22(12):1339-1354.

16. Buede, Dennis (2000) *The Engineering Design of Systems (Models and Methods).* Hoboken, NJ: John Wiley & Sons

17. Chappelle, Douglas E. (2000) "Are there too Many MBA's in Aerospace" *Aerospace and Electronic Systems Magazine, IEEE,* 15(5:May): 3-5

18. Christensen, David S., Searle, David A., and Vickery, Caisse (1999) "The Impact of the Packard Commission's Recommendations On Reducing Cost Overruns On Defense Acquisition Contracts" *Acquisition Review Quarterly.* (Summer)

19. Christensen, David, Templin, Carl, (2002) "EAC Evaluation Methods: Do They Still Work" *Acquisition Review Quarterly.* (Spring):105-116.

20. Churchill Jr., Gilbert A., (1979) "A Paradigm for Developing Better Measures of Marketing Constructs" *Journal of Marketing Research*, 16(February): 64-73.

21. Conrow, Edmund H., (1996) "Some Potential Benefits of Using Cost as an Independent Variable in Defense Programs: A Step in a Different Direction" *Project Manager,* (November-December): 48-50.

22. Cooper, Robin and Kaplan, Robert (1991) *The Design of Cost Management Systems: Text, Cases, and Readings* Englewood Cliffs, NJ: Prentice Hall

23. Cooper, Robin and Slagmulder, Regime (1997) *Target Costing and Value Engineering*. Portland, Or: Productivity Press

24. Cooper, Robin and Slagmulder, Regine (1999) "Develop profitable new products with target costing" *Sloan Management Review*, 40(4: Summer): 23-33.

25. Creese, Robert C. (1999) "Target Costing and Value Engineering" *Cost Engineering,* 41(11: Nov): 13-14

26. Criscimagna, Ned H. (1998) "Cost as an Independent Variable" *Selected Topics in Assurance Related Technologies (START)*. 5(2): 1-4.

27. Cummings, John (1997) "Cost as an Independent Variable involves System User" *Logistics Spectrum,* 31(5: Sep/Oct): 25-26.

28. Defense Contracts: [1] (1998) *Defense Daily,* 200(7):1.

29. Dekker, Henri and Smidt, Peter (2003) "A survey of the adoption and use in Dutch firms" *International Journal of Production Economics,* 84(3:Jun): 293-306.

30. Department of Defense. (1996, March 15). DoD Regulation 5000. 2-R, Part 3.

31. Fitzgerald, Kevin R. (1997) "Cost Tops all Design Concerns" *Purchasing*, 122 (5:Apr 3): 64-65.

32. Foweler, Floyd (2001) "Ch. 5: Designing Questions to be Good Measures," *Survey Research Methods*. 3rd ed. Thousand Oaks, CA: Sage Publications

33. Freeman, Tom (1998) "Transforming Cost Management into a Strategic Weapon" *The Consurtium for Advanced Manufacturing—International*. pp. 1-20

34. Gagne, Margaret L. and Discenza, Richard (1995) "Target Costing" *The Journal of Business & Industrial Marketing,* 10(1):16-23.

35. Gotwald, Allen L., Grahm, David R., Kaye, Micheal A., Sobota, Mark S. (2000) "Cost as an Independent Variable: Principles and Implementation." *Acquisition Review Quarterly,* 7(4:Fall): 353-371.

36. Herald, Thomas E. (2000) "Technology Refreshment Strategy and Plan for Application in Military Systems – A How to Systems development Process and Linkage with CAIV" *IEEE Conference Proceedings* pp.729-736.

37. Hildebrandt, Gregory G. (1998) "The Use of Performance Incentives in DoD Contracting" *Acquisition Review Quarterly*. (Spring): 217-234.

38. Kato, Y (1993) "Target Costing Support Systems: Lessons from Leading Japanese Companies" *Management Accounting Research.* 4(1:March): 33-47.

39. Kroll, Karen (1997) "On Target" *Industry Week*, 246(11:Jun 9):14-18.

40. Lee, John Yee (1994) "Use Target costing to improve your bottom line" *The CPA Journal*, 64(1:Jan): 68-71.

41. Magery, J.M. (2001). "Elements of a Systematic Review" *International Journal of Nursing Practice*, 7, 376-382

42. McKinney, Col. Richard W. (1999) "EELV meets CAIV" *AeroSpace America*. (May): 68-72.

43. Monden, Yasuhiro, Akter, Mahmuda and Kubo, Naoto (1997) "Target Costing Performance Based on Alternative Participation and Evaluation Methods: A Laboratory Expirement" *Managerial and Decision Economics*, 18: 113-129.

44. Mount, Mike (2004) "Army Cancels Comanche Helicopter" Retrieved December 9, 2004 from http://www.cnn.com/2004/US/02/23/helicopter.cancel/

45. Parker, Miles (1997) "Mission Possible – Improving Design and reducing costs at Boeing Helicopter" *IIE Solutions*, 29(12: Dec): 20-25.

46. Pringle, Peter (2001) "The Life Cycle Process" *Manufacturing Engineer,* (December): 284-287.

47. Redfern, Merlin L. (2004) "Value Engineering: Tactics and Pitfalls" *R&D* : 23

48. Rickman, Dale M. (2001) "A New Process For Requirements Understanding" *IEEE DASC 2001 Conference Proceedings,* 4.D: 1-4.

49. Rush, Dr. Benjamin (1997) "Cost as an Independent Variable: Concepts and Risks" *Acquisition Review Quarterly,* (Spring): 161-172.

50. Sakurai, M (1989) "Target Costing and How to use it" *Journal of Cost Management,* (Summer):39-50.

51. Shank, John K. and Fisher, Joseph (1999) "Case Study: Target Costing as a Strategic Tool" *Sloan Management Review* 41(1:Fall): 73-83.

52. Snodgrass, Alan (2001) "Cost as an Independent Variable ('Variable But Not Really Independent')" *Proposal Management,* (Spring): 41-46.

53. Steedle, Lamont F. (2000) "Target Costing" *Issues in Accounting Education*, 15(1:Feb):164-166.

54. Swenson, Dan, Bell, Jan, Kim, Il-Woon and Anasari, Shahid (2003) "Best Practices in Target Costing" *Management Accounting Quarterly,* (Winter)

55. Tanka, T. (1993), "Target Costing at Toyota", *Journal of Cost Management*, (Spring): 4-11.

56. Tani, Takeyuki, Okano, Hiroshi, Shimizu, Nobomasa (1994) "Target cost management in Japanese companies: current state of the art" *Management Accounting Research*, 5(1:March):67-81.

57. Trochim, William M K (2001) *The Research Methods Knowledge Base*. Cincinnati, OH: Atomic Dog Publishing

58. Webb, Alan (1993) "Value Engineering Part 1" *Engineering Management Journal,* (August):171-175.

59. Webb, Alan (1993) "Value Engineering Part 2" *Engineering Management Journal,* (October): 231-235.

60. Webster, Jane and Watson, Richard (2002) "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quaterly,* 26(2):xiii-xxiii.

61. Williamson, Andrew (1997) "Target and Kaizen costing" *IEE Manufacturing Engineer,* (Feb): 22-24.

62. Wollover, David R. (1997) "Quality Function Deployment as a Tool for Implementing Cost as an Independent Variable" *Acquisition Review Quarterly*, (Summer): 315-338.

63. Yoshikawa, T., Innes, J, and Mitchell, F. (1990), “Cost Management Through Functional analysis” *Emerging Practices in Cost Management,* Boston, MA: Warren, Gorham and Lamont