Economic Incentives in Aerospace Weapon Systems Procurement

by

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Abstract

In the last several years, policy makers have attempted to make changes in the defense acquisition system to allow for a structure which provides for the selection and budgeting of the most cost-effective weapons. Senior Department of Defense officials are attempting to shift away from regulation and oversight and towards economic incentives for the procurement of higher quality and lower cost weapon systems. This thesis provides a framework for the establishment of incentives within an aerospace weapon system program.

The objective of this thesis is to provide a framework for government and contractor program managers to develop economic incentives in the future. Changing acquisition policies offer interesting challenges for program managers as they attempt to structure procurement contracts which meet government and company goals and objectives. The framework developed highlights the critical link between the management processes within a weapon system acquisition program and the establishment of economic incentives. Practices are described which help identify, quantify and foster the development of incentives.

The practices discussed derive from four case studies completed as part of this thesis. These case studies document how each program established their economic incentives, and show they were not simply derived from a formula used in the government's weighted guidelines (WGL) for profits, or other procurement directive or list. Each program's economic incentives are tied to risks specific to the completion of that weapon system. Successful economically incentivized programs capture the major risks to execution of a weapon system program and plan for methods to mitigate those risks.

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List of Acronyms

AFB	Air Force Base
ASC	Aeronautical Systems Center
AUPP	Average Unit Procurement Price
CAIG	Cost Analysis Improvement Group
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CEO	Chief Executive Officer
CFSR	Contract Funds Status Report
CSCSC	Cost Schedule Control System Criteria
CY	Calendar Year
DAB	Defense Acquisition Board
DARPA	Defense Advanced Research Projects Agency
DCAA	Defense Contracting Audit Agency
DPRO	Defense Plant Representative Office
DoD	Department of Defense
EOQ	Economic Order Quantity
FAR	Federal Acquisition Regulation
FASA	Federal Acquisition Streamlining Act
FCA	Functional Configuration Audit
FFP	Firm Fixed Price
FFRDC	Federally Funded Research and Development Center
FMS	Foreign Military Sales
FPI	Fixed Price Incentive
FPIF	Fixed Price Incentive Firm
FPIS	Fixed Price Incentive Successive targets
FY	Fiscal Year
GAO	General Accounting Office
IG	Inspector General
IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
J&A	justification and Authorization
LAI	Lean Aircraft Initiative
LRIP	Low Rate Initial Production
LGen	Lieutenant General
MGen	Major General
MIT	Massachusetts Institute of Technology
NDAA	Non-Developmental Airlift Aircraft
PCA	Physical Configuration Audit
PCO	Principal Contracting Officer
PE/PI	Producibility Enhancement/Performance Improvement
PMD	Program Management Directive

PTA	Point of Total Assumption
RFP	Request for Proposal
ROA	Return on Assets
ROI	Return on Investment
ROS	Return on Sales
SAF/AQ	Secretary of the Air Force, Office of Acquisition
SPO	System Program Office
TINA	Truth in Negotiations Act
U.S.	United States
USAF	United States Air Force
VIQ	Variation in Quantity
WGL	Weighted Guidelines
WPAFB	Wright-Patterson Air Force Base

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Chapter 1: Introduction and Overview

The objective of this thesis is to provide a framework for government (Department of the Air Force) and contractor program managers to develop economic incentives in the future. Changing acquisition policies offer interesting challenges for program managers as they attempt to structure procurement contracts which meet government and company goals and objectives. The framework developed highlights the critical link between the management processes within a weapon system acquisition program and the establishment of economic incentives. Practices are described which help identify, quantify and foster the development of incentives.

The four case studies conducted describe programs which are able to identify, quantify and agree upon the major risks to an aerospace weapon system program and can identify economic incentives to mitigate these risks and aid in achievement of program goals. The resulting policy recommendations (aimed at government and contractor program management) identify practices to be adopted which help identify, quantify and foster agreement of the risks and the resulting incentives.

The practices discussed derive from four case studies completed as part of this thesis. These case studies document how each program established their economic incentives, and show they were not simply derived from a formula used in the government's weighted guidelines (WGL) for profits, or other procurement directive or list. Each program's economic incentives are tied to risks specific to the completion of that weapon system. Successful economically incentivized programs capture the major risks to execution of a weapon system program and plan for methods to mitigate those risks.

This thesis develops a framework which describes a common process used to identify the risks for each program and the establishment of economic incentives. This process starts with the program managers' (both contractor and government) ability to communicate the primary goals for the program. The ability to communicate these goals is important because the knowledge necessary to evaluate the risks to the program resides

in people at every level of the organizational structure, not only managers. Specific technical, schedule, cost or other risks must be collected from all levels of the program in order to allow for an adequate risk evaluation. From a thorough risk evaluation, a risk mitigation plan can be formulated, and the most feasible economic incentives will be derived.

Before discussing a program's risks and incentives, one must understand the type of goals the contractor and government establish for that weapon system acquisition program. Table 1 identifies a set of universal goals which are common to most programs. They are not the goals specific to the four case studies, but are more general goals of the acquisition process, and were confirmed during the initial set of interviews conducted during this study.

Government Goals	Contractor Goals
Reduction of unit price to ensure: • Continued funding during budgetary process • Effective use of taxpayers' money	Success of financial measures, to include: • Cover overhead costs • Maintain positive cash flow • Meet corporate targets for return on investments, assets and sales
Meet users' needs and national defense objectives	Enhancing the company's reputation for future competitions
Measure of success which can allow promotion of people working on program	Measure of success which can allow promotion of people working on program
Ability to contribute to bureaucratic structure and job continuation	Job continuation
Problems which do not prove to be embarrassing or important enough to warrant detrimental press coverage	Problems which do not prove to be embarrassing or important enough to warrant detrimental press coverage

Table 1. Identification of Goals for the Government and Contractor

As shown in Table 1, certain goals are common to both the contractor and government, while others are unique to each party. The longer the program can continue successfully, the easier it is to achieve both the government's and contractor's goals. The implementation of successful economic incentives allow the balancing of risk and reward within a program to achieve long term success.

For the purpose of this thesis, economic incentives are defined as contractual clauses, structures or provisions which result in the sharing of resources and responsibilities between the government and the contractor so that the price of the weapon system is reduced, quality is maintained or enhanced, and the contractor (which can include subcontractors and suppliers) is not financially penalized. In addition, with successful incentives, more of the government's and contractor's goals, which are not always financial measures, are met.

1.1 Brief History

Within the last ten years, the United States has experienced significant changes in the way in which it plans and executes its national defense policy. The Cold War has ended, and the U.S. and Russia are no longer involved in an arms race. One of the results of this situation is a change in the relationship between the U.S. government and the companies competing to provide the weapon systems which aid in national defense. Historically, efforts had been focused on the technical capabilities of weapon systems, and contractors felt confident that if a weapon system was approved for production, they would produce enough units to cover any investments they made and provide a financial reward for the company.

In the current defense acquisition environment, not only technical, but cost and schedule requirements must be met in order for a weapon system program to be approved, through the milestone approval process of the Defense Acquisition Board (DAB), for the phase of full-scale production. Once in production though, the annual production rate is subject to the constraints of the budgetary process approved by Congress. Annual changes occur due to competition between Department of Defense (DoD) programs for their portion of a declining defense budget which cannot meet all of the weapon systems users' needs. The result is that each production program must be flexible enough to survive annual changes. One method to build flexibility into a program is through economic incentives. With successful incentives, more of the government's and contractor's goals can be met.

National security is a major issue for most U.S. citizens today. Part of this is due to the sheer size of the defense budget, while part of it is due to concern over whether the U.S. has seen an increase in national security proportionate to the growth of the cost of weapon systems. Since the mid-1980's there has been a growing perception of mismanagement, waste, and even fraud and abuse in defense budgeting and procurement. The newspapers pointed to toilet seats, hammers and coffee pots costing thousands of dollars as examples of this. Reports by the General Accounting Office and the House Committee on Government Operations[1] have actually shown that the Department of Defense is one of the best-managed federal agency, but that does not change the perception among policy makers (especially Congress) that additional regulation would help ensure that abuses do not occur.

In the last several years, policy makers have attempted to make changes in the acquisition system to allow for a structure which provides for the selection and budgeting of the most cost-effective weapons. Senior Department of Defense officials are attempting to make a shift away from the regulation of quality and costs in the procurement of weapons to the creation of incentives for higher quality and lower costs.[2] This thesis examines provides a framework for the establishment of incentives within a weapon system program.

1.2 Structure of the Thesis

Chapter 2 introduces a summary of the pertinent information gathered during the literature review conducted. Sources from economics, business management, and systems engineering are discussed for their contribution to the framework established within this thesis.

The management of an integrated process and product development (IPPD) effort from systems engineering literature is discussed. One of the tools of IPPD, integrated product development teams (IPTs), are seen in the case studies to aid in the flow of

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[1] Comptroller General, "Acquisition of Major Weapon Systems," Department of Defense Report B163058, July 1972, and "Inaccuracy of Department of Defense Weapons Acquisition Cost Estimates," House Committee on Government Operations, November 16, 1979.

[2] Jacques S. Gansler, *Affording Defense*, (Cambridge, MA, 1991), p. 12.

information within a weapon program. Information flow is critical to establishing program incentives because it allows the identification of risks to the program goals.

The financial measures of return on assets (ROA), sales (ROS), and investments (ROI) will be reviewed. These description of practical financial measures are discussed because of their use as measures of performance within companies.

The principal-agent relationship within economic theory is reviewed for its applicability to weapon system procurement. The presence of asymmetries of information within the regulatory environment of procurement leads economists to recommend the use of competition and watchdogs, in conjunction with audits, to lessen the different amounts of information.

Chapter three identifies the methodology used for the research performed. The progress of the study is traced. The information discussed in this thesis initiated with interviews with government and contractor personnel working on weapon system acquisition programs and an accompanying literature review. This resulted in an initial theoretical framework from which a selection of four case studies were selected.

The fourth chapter will document the four case studies conducted with munitions and aircraft programs. Program specific historical data and incentive information will be discussed.

Chapter five performs an analysis of the case study data. Similarities and differences will be highlighted among the case studies, and conclusions will be explained in accordance with their relationship to the process used to identify economic incentives. A distinction between case study conclusions which may be program specific as opposed to conclusions which can be generally applied will be drawn.

The final chapter will identify the important findings and conclusions which result from this research effort. The steps necessary for determining the appropriate incentives for a weapon system program will be discussed, along with noted enablers and barriers to this process. Finally, implications for government policy will be addressed, including recommendations for program managers.

Chapter 2: Literature Review

Prior to conducting any case studies, and to complement the information gained from the exploratory interviews, a literature review was conducted. Its purpose is to aid in the development of a preliminary conceptual framework, and to develop the criteria for selecting the case studies performed. While may sources were consulted due to the integrative nature of this research, systems engineering, business management and economic theories are discussed because of their applicability to the establishment of economic incentives in aerospace weapon system programs.

2.1 Integrated Product and Process Development

Integrated product and process development (IPPD), which is found in the systems engineering literature, deals with the management of the design effort for a complex system. Several key features of IPPD are:

- Concurrency of design efforts from the start of development
- Early risk identification
- Total system lifetime cost consideration
- Early buy-in of all stakeholders, including the customer.

IPPD incorporates similar concepts to Air Force initiatives Total Quality Management and Concurrent Engineering. The tools of IPPD include uncertainty management, information management and access, and cost modeling. The objective is to involve stakeholders who hold the key engineering and manufacturing knowledge and data necessary for the successful development of a weapon system.

One of the tools of IPPD is the use of Integrated product Teams (IPTs). The use of multidisciplinary teams helps information flow during the phases of program development, and results in a more effective identification of risks to the program. In highly complex systems, such as defense aircraft, methods to manage the interfaces between groups of people, hardware form fit and function, and processes are crucial. Decision making involves technical choices and value judgments, and requires information. IPPD is the management of the tools and methods for delivering this information.

2.2 Business Financial Analyses

A goal identified in Table 1 was to meet corporate targets for return on assets, investment and sales. This goal is necessary because companies seek to maximize the value of their firms' stocks. By the actions of their managers, a company affects the stream of income to investors and the riskiness of that income stream. When investors purchase a stock, they believe a company will provide an expected rate of return. In order to maintain that expected rate of return, managers of a company must maintain certain financial metrics of performance. The most popular of these are return on assets (ROA), return on investment (ROI), and return on sales (ROS), and are known as profitability ratios. They are calculated at different levels within a company, and are used by investors to measure two companies performance against each other, or one company against an industry average. These ratios provide some information about how a firm is operating, and show the combined effects of liquidity, asset management, and debt management on operating results. As ratios, ROA, ROI and ROS each have the same numerator - net income, while the denominator varies. ROA is income divided by assets, ROI is income divided by investment, and ROS is income divided by sales. These are important financial measures to note because managers' performance is measured against established corporate targets. The use of these metrics confirms that profit rates are not the only concern for companies when structuring incentives on a contract.

3.3 Economic Theory

Three types of regulatory constraints are identified in economic theory: informational, transactional, and administrative and political.[3] The case studies in this thesis, and the resulting framework concern themselves primarily with the informational constraints.

A situation known as a principal-agent relationship occurs when asymmetries of information exist between individuals subsequent to the signing of a contract. Asymmetries of information is defined as unequal amounts of knowledge held by parties to a contract. The economic literature refers to two types of informational problems which

are typical in principal-agent relationships. One is hidden actions (traditionally referred to as moral hazard situations), and refers to when a principal is unable to observe how hard the agent is working. For example, the quality of an employee's work is difficult for an employer to monitor, or consumers can face problems monitoring the quality of repairs on an automobile. Moral hazard refers to the efforts put out by agents,

> but it should be interpreted more broadly. Managers' allocation of perks,...delay of distasteful actions (e.g., layoffs during periods of low activity), purchase of materials and equipment at high prices, and hoarding of engineers or machines not required under current contracts but useful for commercial profits or for winning future contracts are examples of "negative effort."[4]

The other case, hidden information, refers to when an agent possesses superior information about opportunities over the principal, and is known as adverse selection. In this case, each party to a contract may have different probabilities of experiencing certain outcomes, and certain parties know the probabilities more accurately. For example, defense contractors are usually more knowledgeable about the likely cost of developing a new weapon system than the DoD.

Informational asymmetries are the primary reason for audits and the use the of Truth in Negotiations Act (TINA) during proposal negotiations. TINA sets requirements for information a contractor must submit in a proposal. This information includes cost and pricing data, commercial sales and discount data, company cost accounting standards, cost estimating systems used in the proposal, and indirect cost rates. These are attempts to provide the government with as much information as possible about the contractor's basis for establishing cost and price in a proposal. The effectiveness of TINA and the audit system to carry out this function has been questioned.

Through whatever means, though, the ability to flow information from the contractor to the government is always important to government managers during the procurement of weapon systems programs. Laffont and Tirole take "the auditing structure as given, but discuss alternative and more subtle ways of creating information to lessen the

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[3] Jean-Jacques Laffont and Jean Tirole, *A Theory of Incentives in Procurement and Regulation*, (Cambridge, MA, 1993), p. 1.

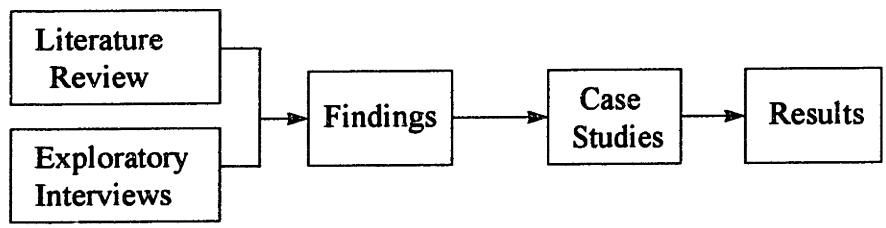
informational asymmetries: the promotion of competition and the involvement of a watchdog supervisors."[5] They do not discuss the use of IPTs as a potential method to reduce informational asymmetries. While competition issues and the resulting incentives appear in the case studies, the use of IPTs to reduce information asymmetry also appears to be effective.

It is the combination of the ideas from the disciplines of systems engineering, financial analysis for businesses and the economic literature which generated the framework used to analyze the case studies performed.

[4] Ibid., p.1.
[5] Ibid., p.3.

Chapter 3: Research Methodology

While the previous chapter identified the literature supporting the framework used for the case study analysis, this chapter will detail the steps involved in performing this research. The information presented in this thesis initiated with a literature review (discussed in Chapter 2) and exploratory interviews which were conducted from November, 1995 through February 1996. The literature review and initial (exploratory) interviews were conducted in order to narrow the scope of the research to criteria which could be examined with four case studies. From this work, a preliminary framework was developed which was applied to future case studies. Figure 1 represents an overview of the research process and the activities performed during each step. Details of how the interviews and case studies were performed are discussed below.



Participants		Participants	
•Industry Companies 3 Airframe 2 Engine 3 Electronics •9 Government Offices at WPAFB •2 Government Offices at SAF •4 FFRDC/universities	•Revise boundaries of study •Establish criteria for case studies •Preliminary conceptual framework •Identify emerging barriers, enablers & metrics	•C-17 •C130J •Munitions programs	•Analysis •Conclusion and Findings •Recommendations

Figure 1. Research Methodology

3.1 Initial Interviews

From November, 1995 through February 1996, exploratory interviews were conducted. Company and government experts were asked questions, and issues and concerns were discussed. In order to represent the three sectors (airframe, engine and

electronic) within the defense industry, the interviews were conducted at three airframe companies, two engine companies, and three electronics companies. In addition to the Lean Aircraft Initiative (LAI) industrial consortium members, nine government offices at Aeronautical Systems Center (ASC), Wright-Patterson Air Force Base (WPAFB), two offices at the Pentagon at the Secretary of the Air Force level, and four Federally Funded Research and Development Centers (FFRDCs) or other universities were visited. Over 100 people were interviewed during this phase of the study. The individual interviews had been selected to represent a broad mix of users, implementers, and decision makers. The results of these interviews were compared in order to revise the boundaries on the study, and establish the criteria for selection of the case studies. These interviews were used to identify emerging barriers, enablers, and metrics.

3.2 Case Studies

The findings from exploratory interviews and the literature review were structured within an initial conceptual framework. This framework was used to establish the criteria for the case studies, and led to a set of questions asked during each of the case study interviews.

The purpose of the case studies was to discern the relationship between goals, processes, and economic incentives, and to determine what factors were important to successful outcomes for the programs. The research looked for the important drivers which enabled a program to implement economic incentives.

The criteria for the selection of the case studies were:

- creative contract modifications which were acknowledged by community members (used LAI consortium members to reach consensus agreement) to be innovative and different
- use of competition (as opposed to sole source justification) by government to reduce unit costs on the contract examined during the case study
- evidence of incentives used to mitigate barriers found through initial interviews or enhance advantage of enablers
- representation of aircraft and munitions sectors of aerospace community

- commercial versus military hardware development which refers to the use of commercially available, off-the-shelf hardware, as opposed to hardware developed within the weapon program.

Program	Use of Competition	Barriers/Enablers	Sector	Hardware Development
Munitions I	No	Yes	Munitions	Military
Munitions II	Yes	Yes	Munitions	Commercial
C-130J	No	Yes	Airframe	Commercial
C-17	Yes	Yes	Airframe	Military

Table 2. Case Study Criteria Summary.

The selection of these four case studies attempted to determine if the types of incentives used differed greatly due to differences between the criteria identified in Table 2. Since each was identified as using creative contractual modifications, the hope was to be able to identify patterns in the incentive determination process which would appear from the case studies.

The technology for each system was considered mature and commercially available if developed components were used and a protracted development phase to demonstrate the feasibility of incorporating the technology was not required. The C-130J program was required to spend several years' effort developing some of the hardware upgrades for their program and involved some aspects of military hardware development also. On a relative scale, though, this was not the equivalent of an entire new aircraft system, like the C-17 program. This is not meant to imply that "mature" technology programs do not face technical problems.

The two case studies involving munitions' weapon systems (bombs) whose government offices were based at Eglin AFB in Florida, and the two aircraft weapon systems' government offices were resident at WPAFB in Ohio. The contractors' facilities are located throughout the US. Each of these programs agreed to provide information on

how they implemented the economic incentives which are currently structured within their contracts. These case studies were intended to identify the key parts of the processes used, and identify any common parts of that process which either helped (enablers) or hindered (barriers) the process.

Visits to each of these sights occurred, and interviews were conducted with team members who had participated in the process of establishing program economic incentives.

One of the methods used to insure the reliability of the data was by having each interview participant receive the same written set of questions and brief summary of the research prior to the interviews. Researchers familiar with the case study method were consulted prior to conducting formal interviews for integrity of the methodology. Two researchers attended each of the interviews, and reviewed the notes from the interviews for concurrence. Effort was taken to ask the questions in the same order and present them in a similar manner during each interview.

The validity of the evidence was protected by using a group of industry personnel to "pre-test" the list of questions before conducting formal interviews. The information generated from the pre-test was contrasted against the conceptual framework and case study criteria. The goal of the "pre-test" was to refine the questions in order to insure the answers to the questions provide the desired information about the process.

The representativeness of the evidence was insured through the set of people interviewed for each case study. Care was taken to interview people involved throughout each program's incentive process in order to cover differing perspectives. Not only were program managers, and contracting personnel interviewed, but also engineering and production workers. Interviews attempted to covers several layers of the management chain in order to verify if what managers thought was being passed on was indeed received by lower levels. These interviews conducted ranged from thirty minutes to several hours, were conducted with individuals and small groups (three to five people). The individuals interviewed belonged to several organizations, including the Air Force System Program Office (SPO), the contractor's plants, the Defense Plant Representative's Offices (DPRO), and officials who worked in the Pentagon in Washington, D.C.

The significance of the information is two fold. First, each case study provides insight into how one program generated their set of economic incentives. In general, this is not well documented in the procurement community. Second, the comparisons between the case studies to find similar and dissimilar practices provide significant information on what contributes to the framework developed.

Chapter 4: Case Studies

4.1 Munitions Cases

Two case studies examined programs producing munitions weapon systems, and are designated Munitions Case I and Munitions Case II. This section describes the history and major contractual conditions for each program. In both cases, the government SPO is resident at Eglin AFB, in Florida, while the contractors are located in other states in the U.S.

4.1.1 Munitions Case I

The first munitions case involves an Air Force acquisition program initiated with a DARPA (Defense Advanced Research Projects Agency) technology demonstration from 1978-1980. It was one of the first developments of a "smart" bomb. The technology demonstration was successful, the DARPA project was completed, and the funding ceased. The company building this hardware identified Air Force requirements which their technology would satisfy which were not currently being met. The contractor conducted a study which identified advantages to the Air Force by developing their technology. The Air Force conducted a competition, and the winner was awarded a full scale development (FSD) contract for development of a munition system.

The company producing the hardware in Munitions Case I (subsequently referred to as Munitions I) received a fixed price-incentive (FPI) contract to develop their technology into a full scale munition system. In 1988 and 1989, severe technical problems occurred, and questions arose concerning the ability of the weapon system to meet the requirements on contract. Due to these technical difficulties, the FSD contract experienced cost overruns, and exceeded the ceiling price. This essentially converted the FPI type contract into a Firm Fixed Price (FFP) contract. The contractor lost significant amounts of money (millions of dollars), and brought suit against the U.S. government. At the same time, the Air Force was attempting to issue a "show cause" contract termination letter.

Over the next two years, the technical and financial issues were addressed and resolved, and the program restructured. During this time, the Air Force continued to identify a mission need for the munition program. The contractor stated that they have always had "constant and intense" support for their hardware to satisfy the mission requirements of the Air Force. The company recouped 30-40% of their financial losses, and in 1991 the Air Force requested a proposal to produce this system.

In 1991, the contractor submitted a proposal for the first Low Rate Initial Production (approximately 100 per year) run (LRIP 1), along with not-to-exceed values for LRIP 2 and 3. This proposal contained a much higher unit price than the Air Force had expected. This affordability concern delayed the decision to proceed into production by the DAB. Discussions (characterized as very difficult by Air Force and contractor program personnel) occurred concerning learning curves, recurring versus non-recurring work, and other issues in an attempt to address the affordability of this weapon system. While the technical, cost and schedule problems were resolved, an adversarial relationship between the Air Force and the contractor existed which made the negotiations difficult.

The government and contractor identified that a difference in ground rules caused the estimates to be higher than projected. The original estimates were generated from predicted unit production costs based upon a total production of 20,000 units at the rate of 2,500 per year. With the end of the Cold War, the Air Force had reduced the total number of units to 5,000 with a much lower annual production rate of approximately 400-500 units per year. These differences were resolved in a meeting between the Under Secretary of Defense for Acquisition and Technology and the contractor's Chairman of the Board. With the affordability issue addressed, the DAB approved the decision to proceed into production. In March, 1992, the LRIP 1 production contract was finalized as an FPI contract, and the contractor started producing hardware.

The meeting between the Under Secretary of Defense for Acquisition and Technology and the contractor's Chairman of the Board was seen as an example of the inability of the government System Program Office (SPO) and contractor's program office to reach agreement on program costs. The relationship between the government and contractor continued to be adversarial, and required resolution of numerous issues at

upper levels of management. It was rare for any consensus to be reached without involvement of the government and contractor program managers.

In 1992 the Air Force appointed a new SPO program manager. He established an excellent working relationship with the contractor program manager, and conveyed the need for all government and contractor personnel team members to develop solid working relationships with their counterparts. He encouraged frequent phone conversations between government and contractor personnel (weekly at a minimum), in addition to monthly and quarterly visits to prime and sub-contractor plants. The government and contractor program managers analyzed the processes they used to complete work, and attempted to make them more efficient. Locations where IPTs could be implemented were identified. Even with a change in the government program manager in 1996, these IPTs continued to increase their effectiveness and enhanced information flow in the Munitions I program.

One example of this increased sharing of information is the annual production contract negotiations. The AF SPO does not issue a formal request for proposal (RFP), as it has in the past. They currently call an IPT meeting, identify the requirements and any changes from the previous year's contract, and then determine, as a team, what should be included in the proposal. Since actual production costs exist for several years, future production costs can be predicted with higher certainty. Technical changes are still occurring, though, and support levels for engineering and other functional organizations must be agreed upon. The IPT discusses all issues, and identifies those which cannot be agreed upon at their level. These issues are then immediately brought to the program managers' attention for resolution. What had traditionally taken 2-3 months to accomplish, now is completed in 2-4 weeks.

Another example of the increase in information sharing is the development and continued updating of a weapon system cost model. This effort was initiated in the early 1990's when a pricing model was developed to predict future annual production contracts. The model incorporates the information from each annual production lot, and involves both contractor and government input. Since approximately 60% of the weapon system cost is driven by suppliers and sub-contractors, the government and the prime contractor

work together to evaluate prices. This access to information helps reach agreement more quickly during annual negotiations.

When evaluating the current incentives on contract for the Munitions I program, attention must be paid to the first full rate production contract issued in May, 1996. The program IPT structure incorporated significant changes into the contract design because of new acquisition policies. Though the negotiation lasted for many months, agreement was reached, risk was shifted from the government to the contractor, and several AF acquisition policy initiatives were implemented. The most significant of these differences were: (1) Incorporation of performance specifications, (2) Introduction of a warranty, and (3) Contractor assumed responsibility for configuration control, as shown in Table 3.

1. Incorporation of performance specifications.
2. Introduction of a warranty.
3. Contractor assumed responsibility for configuration control.

Table 3. Most Significant Changes to Munitions I Production Contract.

In a change from policy of the 1970's and 1980's, current acquisition policy encourages the development of performance specifications which the contractor must meet, minimizing military standards and regulations, and implementing a full warranty. The Munitions I program was developed the previous policy where the contractor developed a weapon system which met all military specifications and requirements on contract, and had no warranty liability. An IPT was formed to identify potential concerns associated with implementing these changes.

As issues and strategies were discussed within the IPT, balances between the assumption of additional risks and the use of incentives were developed. While the specific numbers were not settled until discussions reached the government and contractor program managers, interviews with the IPT members determined that they felt that any issue could be discussed within the IPT, and were able to identify the strategies used to deal with each issue. These sentiments indicate a level of trust and mutual respect between the IPT members.

The contractor assumed the risks associated with a warranty, in return for two changes to the contract. The first was a limited liability clause. The contractor balances the risk associated with a warranty which wasn't part of the original development effort, with a liability limited in absolute dollars. Second, the control of the weapon's configuration was transferred to the contractor. Contractor management of configuration control allows them the authority to make any needed changes to support warranty requirements and manage the trade off between cost and requirements.

The financial changes to the contract included changing the share ratio on over/underruns from 70/30 to 50/50, the profit rising slightly from 12.4% to almost 13%, and the contract staying as an FPIF instead of changing to FFP. While the AF SPO maintained the FPIF contract structure because the contractor had underrun the contract for the three previous years and this was in the government's best interest, the SPO created an economic incentive by reinvesting several million dollars in savings from the previous year's contract in accelerating the production rate.

These clauses and conditions allowed the Munitions I program to achieve several goals. The common goal of unit cost reduction was achieved since the unit cost has dropped more than 25% since LRIP 1, comparing annual contractual costs against initial cost projections. The favorable financial performance has been coupled with several technical improvements identified by the munitions' users. Cost reimbursement programs for selected productivity and technical enhancements provide an incentive for the contractor to make additional investments. The government's goal of implementing acquisition policies was achieved with the full rate production contract in 1996, and allows for a potential reduction in SPO personnel by requiring less oversight of requirement and specification compliance.

The contractor believes that the reduction in unit cost helps to confirm the government commitment to 5,000 units, and may offer the opportunity for a future overseas market. They also believe that the continued success of the program financially and technically allows for an enhancement of their corporate reputation within the government. The contractors feels that this is very important for future competitions for new contracts and programs.

4.1.2 Munitions II Case Study

This case study involves a program just beginning its production phase. Two prime contractors participated through the development phase, and a competition was held to select the contractor awarded the final development and production contracts. This program was designated a pilot acquisition program as part of the reform policies advocated by the Office of the Secretary of Defense and the Department of the Air Force. Numerous regulations were waived by the Secretary of the Air Force including the cost accounting standards. This relief provided high level visibility and access to many senior officials for decision-making authority. Mrs. Druyun (the USAF's principal deputy Assistant Secretary for Acquisition and Management) were noted during numerous interviews as a key official who provided support for policy implementation.

The government program manager believed in the advantages of an IPT organization, and created an advocacy and core IPT team structure during the eighteen month EMD phase. This structure was designed to aid each of the two contractors and to further the government's goals. The advocacy IPTs were resident at the government SPO office and consisted of 10-15 people, but traveled frequently to the contractors' plants, and communicated at least weekly, and often daily with telecons and video telecons. The advocacy IPTs were directed to help each contractor make the best bomb possible for the lowest price. They managed all the government interfaces, and had automatic authority for $100K and 30 days schedule deviation. They were not part of the source selection team, did not provide cross communication between the two contractor teams, and had no requirement to be objective. Both government and contractor personnel interviewed identified the advocacy IPTs as an integral part of a government/contractor team where information and communication flowed freely, and where frequent informal communication occurred.

The core IPT had a much different role. They were a group of 10 people charged with conducting the source selection competition to down select to a single contractor. They allocated limited government resources such as test facilities, aircraft, test ranges, and wind tunnels. They managed all external government interfaces, all funding issues and concerns, and overall requirement decisions. The core IPT was responsible for developing

a new type of source selection called the rolling downselect, and the business strategy which addressed warranty, schedule, quantity and metric identification for program execution.

The primary metric used for comparison during the first development phase was the Average Unit Procurement Price (AUPP). This metric was identified in the transmittal letter for the updated RFP in August, 1993, and continues as a measure on the program today. The AUPP was used as the critical measure of success for the rolling downselect. The major objectives associated with the AUPP are identified in Table 4.

- Provided visible sign of progress
- Basis for measure of progress without comparing contractors
- Clearly tied all actions to price performance
- Provided clear visibility for trade off between requirements and cost
- Included all recurring lot procurement costs

Table 4. AUPP objectives.

The contractor who won the rolling downselect received a contract for the second phase of development, and options for production lots 1 and 2. This included a clause in the contract for the AUPP extended for lots 3-5, with the intention of negotiating a new curve for lots 6-11 after lot 5 was completed. The contract Justification and Authorization (J&A) approved by the government included all 11 production lots, and was considered an indication of government long term commitment by the contractor, though the production lots would be authorized annually.

The contractor who won the downselect made a management decision to average the AUPP over lots 1-5 to show a lower price for lots 1 and 2. This was important to their success because the near term lots 1 and 2 were weighed more heavily in the downselect criteria than the farther term lots 3-5. These criteria were available to all contractors for review, and proved to be critical to the final decision.

There are also several non-financial incentives in the production contracts for the contractor. These include continued waiver of cost accounting standards (including

TINA), reduced DPRO oversight requirements, and minimal inspection requirements. Most of these incentives continue predicated on the contractor's ability to meet his AAUP targets in the future production lots. The government views this as an incentive for technology insertion, contractor investment, and a method to reduce unit price, while the contractor sees distinct advantages in oversight, overhead, and potential profit gains.

Each production lot option is implemented as a FFP annual contract, so that the contractor can keep any gains reaped due to lowering the AAUP in that annual contract. Also, as long as the contractor meets the price commitment curve, the proposal for the annual production contract does not require submittal of cost and pricing data. This significantly cuts down costs associated with preparation and oversight of each annual proposal.

The competition between two contractors during the rolling downselect allowed competition to play an important role in the type of incentives used in this program's contracts, and allowed the government to shift a majority of the risk to the contractor. The winning contractor used two methods to manage this risk. One approach involved sharing the risk with suppliers and sub-contractors. Those that successfully contributed to reducing the AUPP received a share of the subsequent financial gains. The contractor also implemented an employee incentive program at their plant. This program distributed some of the financial gains associated with reducing AUPP directly to employees working on the development program.

Prior to receiving the proposals for the second development phase and production lots, the initial government estimate (generated within the program) for the unit price of these bombs was $30K-$60K each. An independent government estimate (non-program personnel) estimated unit price at $40K. The government target price was $40K. The final long term price commitment for 74,000 bombs was $15K (lot 11). Depending on how many bombs are purchased (estimates between 40,000 and 80,000 are reflected in the cost model), the total savings seen by the government could be between 2-4 billion dollars. This is with a bomb design which met all requirements.

The program is currently working through technical difficulties in testing the flight of the bomb and aircraft integration efforts, and schedule slips have occurred. Several

years will prove the viability of the AUPP commitment, the risks assumed as a result of the competition, the success of the incentives placed on contract, and the actual savings incurred.

4.2 C-130J Case Study

The C-130J is the current production model of the Hercules aircraft. The C-130 aircraft has been in production for more than 30 years. It first flew in 1954, and in 1956 the first C-130A was delivered to the U.S. Air Force (USAF). Over 2,100 aircraft (of more than 55 versions) have been delivered to more than 65 countries worldwide. The information provided for this case study reflects the contractor's perspective, and is not confirmed by the Air Force SPO at Wright-Patterson AFB.

Numerous hardware changes to the "J" model C-130 necessitated a development period for the aircraft. Lockheed Martin approved corporate funding for this development in August 1991. The primary goal of this program was to minimize the cost of ownership. With that in mind, the C-130J management used a 2 to 1 payback ratio for approval of technology insertion and configuration changes. For every $1 in development costs spent, they expected to see $2 in lifecycle cost savings. The investment payback analysis used a given number of airplanes, and required performing greater than 100 trade studies. In addition, three of Lockheed-Martin's major customers had performed lifecycle cost studies which were incorporated in the investment decisions. In addition, care was taken to avoid implementing technical components which had yet to be proven. Efforts were made to bring mostly off-the-shelf technologies into the aircraft development when meeting the payback ratio.

In March, 1994, Lockheed Martin finalized their commercial acquisition strategy, and September 27, 1994, SAF/AQ (Department of the Air Force office responsible for Acquisition policies and practices) hosted a joint government/contractor meeting to discuss acquisition strategy, chaired by Mrs. Druyun. The decision was made to pursue as commercial an acquisition as possible for the Air Force. This decision included the following components:

- The C-130J SPO was pursuing a two part commercial acquisition, where two C-130H aircraft on contract for 1995 would be changed to C-130J aircraft, and a new five year option contract would be issued which was a paradigm shift from government contracting as usual to commercial item contract.
- The contract would contain as few clauses, contract data requirements, military specification and standards as possible.
- The US government must be the most favored customer, and would always receive the lowest price for aircraft.
- The user must specify aircraft performance requirements, no statement of work would be issued.
- The C-130J must be as mission capable as the C-130H.

With the passage of the Federal Acquisition Streamlining Act (FASA) in 1994, the C-130J contracting officer (Mr. Ken Taylor) was able to pursue a strategy of purchasing C-130J aircraft in as commercial a manner as possible. The FASA mandates that the US government should maximize the utilization of commercial items, and to acquire those items in a manner similar to that used by the commercial business sector. The C-130J program was also designated a regulatory pilot program with the support of Mrs. Druyun and Mr. Kaminsky, which allowed waivers of regulations (such as TINA, and certain standards and specifications) needed to sell a commercial item (C-130J) under a military contract. Even with these two initiatives, Mr. Taylor (the government Principal Contracting Officer (PCO) had a very difficult time getting approval for the C-130J contract. Mr. Taylor was dedicated to implementing commercial practices as part of the contract, but this sometimes conflicted with government contracting goals as set by the government procurement community.

In September 1995, the C-130J was designated as a commercial item by the contracting officer, because of the history of the program, the funding of the development entirely by corporate means, and the manner which Lockheed Martin is selling and qualifying the program without government contracts. The C-130J program has an export license from the State Department which allows them to sell the aircraft direct to foreign

countries, not through the government's Foreign Military Sales (FMS) structure on an existing government contract. In 1995 the United Kingdom and Australia committed to purchasing aircraft as launch year customers.

4.2.1 C-130J Commercial Item Contract

The C-130J's government contract was developed in accordance with the Federal Acquisition Regulation (FAR) part 12, and FASA. As a commercial item, the contract required no military specifications or standards, as well as substantially reducing or tailoring the FAR clauses included. (Please see Appendix for additional contract details.) The designation as a commercial item was critical for Lockheed Martin since the FAR specifies that government contracts cannot recover any prior period expenses. The commercial item designation allows for recovery of the development expenses, since pricing was based upon a price comparison, a government estimate conducted by an independent cost group, and a value analysis, but did not require the cost and pricing data included in TINA.

By limiting the contract, and designating the C-130J a commercial item, the following estimates of cost savings were made:

- Reduction of 20-30 Lockheed Martin personnel in contracts, pricing and administrative tasks.
- Government projected Defense Plant Representative Office (DPRO) oversight reduction of 7-10% per year.
- Reduction of the costs associated with acquisition administrative tasks estimated at 30% by the year 2000.
- Government cost avoidance of $3-5M needed during development period.

In addition to potential cost savings, the C-130J contract provides flexibility for US government to purchase aircraft. The five year options from FY 1996 - FY 2000 each allow the purchase from 1 to 32 aircraft. This allows for Congress to purchase additional aircraft during budget markups, which is common for the C-130 program. The AF SPO has indicated that the AF does not currently desire to purchase additional C-130J aircraft, and does so only due to political mandates from Congress. Questions arose concerning

additional purchase of aircraft if it was not produced in the district of the current Speaker of the House.

In return for the commercial contract terms identified in Table 5, the contractor accepts performance risk for the C-130J aircraft, the investment risk for development, the configuration management, responsibility for testing and FAA certification and any risk of

No military specifications	No cost or pricing data or cost reporting
No statement of work (SOW)	Tailored government property clause
Use of performance specifications	Tailored acceptance clause
Commercial payments	Price & value analysis

Table 5. Commercial Item Contract Benefits.

loss. The liability limit of $1.75M on the structural service life was negotiated up from $500K in return for the use of C-130 government tooling on commercial production aircraft. Lockheed martin has also placed a small incentive in the contract for the government to place the C-130J aircraft on contract as early in the FY as possible. For an aircraft placed on contract in the first quarter of the FY, the government receives a $500K discount off the price, a $400K discount in the second quarter and a $330K discount in the third quarter. This government incentive is put in place as an attempt to minimize the company's risk of building aircraft on speculation, and helps cash flow by attempting to eliminate the servicing of debt.

4.2.2 C-130J Program Management

When discussing the need to approve and implement the C-130J commercial item contract, the issues of trust and respect were mentioned frequently. The contractor indicated an extremely close working relationship between key government and contractor management personnel, but three people were mentioned most often. They are Mr. Ken Taylor, the government PCO, Mr. Wender Cox, the C-130J contract administrator, and Lockheed Martin's C-130J program director Mr. Jere Jones. Mrs. Druyun was also mentioned frequently as supportive of what the C-130J program was trying to accomplish,

and necessary to helping to beat down some of the bureaucratic opposition to approval of the commercial item contract.

From the interviews and meetings with the contractor, they stated that a team had formed to work the acceptance of the C-130J commercial item contract. Mr. Taylor and two other contracting officers represented the government, while Mr. Cox, Mr. Jones and several other Lockheed Martin business development, contract administration and financial resource personnel represented the contractor. The contractor continually stated that the approval of the commercial item contract would not have occurred without Mr. Taylor viewing it as a personal challenge and never faltering in his pursuit of the approval. They conveyed numerous items where Mr. Taylor had run into government opposition to his plans, and managed to overcome it and proceed forward. Mrs. Druyun's support was considered critical to these instances also.

Another example of the trust afforded to Mr. Taylor by the contractor is exhibited in the access he received to Lockheed Martin's financial information. In order for Mr. Taylor to satisfy his responsibility as a government contracting officer, he much be certain that the government is receiving the correct value for the price of each C-130J aircraft. To perform the price analysis required for the commercial item contract, a combination of techniques were used. The Cost Analysis Improvement Group (CAIG) performed a government cost estimate, including lifecycle costs, as an independent government organization. In order for Mr. Taylor to perform a price comparison, though, he needed access to contractor financial records which were sensitive to market competition, and considered company sensitive information. Lockheed Martin arranged for Mr. Taylor to have access to the information used to determine market price, which can be different than standard cost roll-up due to the commercial nature of the aircraft. Mr. Taylor was afforded an unprecedented level of access for a government employee to sensitive corporate financial information (including international contracts).

A second example of the team approach to information sharing and communication is displayed through the company's approach to the implementation of commercial inspection and acceptance procedures. They are committed to involving the DPRO in the development of the acceptance and inspection processes in order for them to have an

understanding of what's contained within the work, and help to judge them acceptable. They realize that they are creating new ways of doing business and believe that through IPTs they can address all concerns.

Mr. Jones stressed the role of communication during the implementation and execution of the commercial item contract. He discussed the fact that the intent of the contract is not always captured within the pages and actual wording of the contract, so he, Mr. Cox, and Mr. Taylor must be available to C-130J program personnel. The communication and information that they can pass on to other team members they believe to be crucial to the C-130J's continued success.

4.3 C-17 Case Study

The C-17 program start can be traced to the C-X Program Management Directive (PMD) issued in December of 1979. The C-17 program emerged after a source selection, and a 15 month effort leading to contract award in July 1982. In retrospect, the selection of a fixed-price incentive development contract, with combined development and production appears to have been a poor choice for two primary reasons - cost allocation and technical issues. Technical challenges were apparent at the start of the program, and schedules appeared to have little credence almost from the start of the program. The Air Force continually challenged the contractor's estimate to complete the program, and an apparent confrontational attitude existed between the contractor and the government program office. It is extremely difficult to try to determine which factors were the causes and which were the effects at that time. Since the original participants were not interviewed, the situation was determined through second hand sources. An equitable representation of all the conditions and circumstances is extremely difficult, but it would be fair to say that the situation had been extremely tense between the contractor and the government. It must be noted, though, that it did not appear that any person's actions were not directed toward the goal of delivering a quality weapon system to the US government.

The C-17 program's success at reducing the unit price of the aircraft is attributed to the arrival of MGen Kadish and Mr. Koslowski as the government and contractor

program managers. It must be noted, though, that numerous events in the history of the C-17 program contributed to the rise of the unit price. One of the main reasons for this is the concurrent activities associated with design and production of the C-17 aircraft. Numerous changes of direction affected the design of the aircraft, and this impacted manufacturing and assembly processes. Examples of these changes include:

- Changes to the PMD, the official government statement of program objectives, occurred at least yearly during the 1980's.
- Contract restructures had to be subsequently negotiated following each PMD change to adjust the scope of work to the contractor.
- Direction to subcontract the wing in 1986 due to testing failures.

Changes had to be accommodated by the manufacturing and assembly processes while trying to maintain a concurrent full scale development and production schedule. An example of this is the scheduling of the critical design review and production milestones. While the Critical Design Review (CDR) for the air vehicle occurred in stages during 1988, the assembly of the first test C-17 aircraft (T-1) started in August 1988, and the first production unit (P-1) started in March 1989.

After Secretary of Defense Chaney's review in 1989, the number of C-17's to be bought by the government changed from 210 to 120 in 1990. McDonnell Douglas Corporation had invested (by their own estimates) more than $500 million by 1990. This investment had been made and analyzed using certain assumptions, including build schedules (including annual production numbers). By cutting the number of C-17 aircraft to be purchased in half, there was an impact to McDonnell Douglas' analysis which determined their financial returns (these returns include return on investment and return on assets). Based upon their decision to file claims against the government, it is assumed that their investments could not be justified with 120 aircraft.

4.3.1 The Restructure of the C-17 Program

The C-17 program was restructured and government and contractor claims and counterclaims were satisfied with the Omnibus negotiated settlement between Assistant

Secretary of Defense Deutch and Mr. Stonecipher, CEO of McDonnell-Douglas. The C-17 program, prior to the Omnibus negotiated settlement, had a $1 billion overrun, and the contractor had lost at least $500 million. Numerous technical problems which resulted in engineering changes, such as the failure of two wing structural tests, electronic and navigation system test failures, and landing gear difficulties, along with optimism associated with potential cost savings, impacted the ability to determine the true cost of production.

After the negotiation of the third lot of production aircraft a new approach was adopted for estimating aircraft prices. The contractor did not continue to be optimistic with the price of the aircraft in negotiations of annual lot buys. Pricing was determined by demonstrated performance in conjunction with parametric models, with cost savings not incorporated until demonstrated. What occurred in the fourth, fifth and sixth lot buys was a stabilization of the unit price, at a relatively high level, because the production rate was adjusted and this affected the ability of the factory floor to produce significant savings. In lots 4, 5 & 6, long lead funds had been identified for six aircraft, but the government funding authority was approved for only four units. This long lead change hurt the price because it affected the ability of the factory floor to generate savings by requiring changes to manufacturing and assembly plans. This cut in funding also made the contractor hesitant to make any large investments with a significant overrun and an uncertain government commitment to the C-17 aircraft, so efforts were kept small, and unit price stabilized, but did not decrease significantly. At the same time, the contractor was also starting to see results (such as reduced costs and consistent production cost data submitted in engineering change proposals) from program initiatives such as improved systems engineering and total quality management efforts and the design of the aircraft was stabilizing since changes to accommodate assembly problems were decreasing.

It appears that Mr. Deutch, Mrs. Druyun (the USAF's principal deputy Assistant Secretary for Acquisition and Management), other senior governmental officials, and Mr. Stonecipher determined that a change in leadership was necessary, in order to make the C-17 program successful. The reasons given for this decision were a need to reform the relationship between the government and contractor in order to succeed with the C-17,

and the need to overcome any lasting effects (especially the adversity to taking any risks) from the DoD Inspector General (IG) report which led to removal of four senior governmental officials from acquisition responsibilities in 1993 because of their actions associated with the C-17 program in the past. MGen (then Colonel) Kadish was appointed to be the head of the government SPO at Wright-Patterson AFB, and Mr. Koslowski became the program director of the C-17 at McDonnell Douglas.

In 1993, this new leadership team adopted a strategy to decrease the price of the C-17 aircraft while maintaining or increasing quality. This strategy was influenced by two decisions. The first decision was Mr. Deutch's mandate that the Air Force couldn't buy more than 40 aircraft until it reduced the price of a C-17 aircraft from $260 million. The second decision involved competition to the C-17 program. An alternative proposal, the Non-Developmental Airlift Aircraft (NDAA) from Boeing, was based upon the knowledge that a Boeing 747 was approximately $165 million. The government (this included senior level acquisition officials and Congress) established head-to-head competition between the C-17 and the NDAA, and told McDonnell-Douglas that the technical advantages of the C-17 did not justify the high unit price, and if they couldn't drive the price down to "within a reasonable level" compared to a 747, the government wasn't going to buy more than 40 C-17 aircraft. "Direction received in early 1994 tasked the NDAA system program office to plan for the competitive acquisition of nondevelopmental airlift aircraft as an alternative to or a supplement for C-17 procurement over a range of quantities equivalent in capacity to 14 million ton-miles per day."[6] The NDAA competition and the potential cancellation of the C-17 program were a large incentive to drive unit price down, and was further emphasized by government plans that "authorization to award an NDAA contract remained contingent on decisions rendered subsequent to an integrated C-17/NDAA Milestone II DAB review scheduled for November 1995."[7] This is an example of how the government, as the sole buyer, uses competition to effectively drive unit prices down.

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[6] Dominique B. Meyers, D. Colleen Griffith, Mark D. Bennington, Carol E. White, and Debra Haller, "Use of Commercial Practices Helps Streamline A Complex Acquisition," *Contract Management*, November 1995, p 15.

[7] Ibid., p. 15.

4.3.2 Management of C-17 Program Under MGen Kadish and Mr. Koslowski

The leadership of the C-17 program refers to MGen Kadish (director of the C-17 SPO at WPAFB) and Mr. Koslowski (C-17 program director for McDonnell Douglas) and their management teams. In the C-17 program, these leaders adopted a management style which directly affected the outcome of successful incentives.

One important component of the C-17 leadership was the ability to set the tone of the manner in which business was conducted on the program. Mr. Koslowski and MGen Kadish fostered an environment of mutual trust and respect, because they felt that would contribute to information flow and enable better decision making on the C-17 program. Since this type of relationship cannot be mandated, they provided an example, through their working relationship, of what they expected.

Another aspect of the C-17 leadership was the decision to provide the information needed to all the team members. They conveyed this information through their vision for where the C-17 program was headed, and translated the high level strategic milestones from their senior leadership (such as Mrs. Druyun and Mr. Stonecipher) into program goals which could be assimilated by the C-17 team members. The vision they communicated was one of reducing unit price while maintaining or improving quality. That was seen clearly through the observations from the interviews. They then set specific program goals on an annual basis, which they communicated to all C-17 team members. They provided the direction and information that was necessary, along with the environmental factors, which allowed the C-17 team members to understand and internalize the vision and program goals.

MGen Kadish and Mr. Koslowski were individually selected to run the C-17 program by the Air Force and McDonnell Douglas, respectively, because of their recognized management skills. They, in turn, selected heads of their integrated product teams (IPTs) for very specific traits and characteristics necessary to restructure and manage a new, efficient C-17 program. Both firmly believed that the people working on the new C-17 program wanted to do well, but may have been inhibited by bureaucracy, management, and other factors. They both had a firm belief in the capabilities of their people due to their experiences with prior weapon system acquisition programs, and their

effort to meet all the people who worked with them. MGen Kadish and Mr. Koslowski saw it as their responsibility to give each team what it needed to succeed, and then step out of the way.

Both leaders felt that they had been given great latitude and freedom of action to do what they considered best for the program because of the support of people like Mrs. Druyun and Mr. Kaminski, the Under Secretary of Defense for Acquisition and Technology. They were also aware that they were under careful scrutiny. The close communication and coordination between MGen Kadish and Mr. Koslowski was a departure from previous program managers, and set the example for what they expected from their subordinates. They consulted each other when making decisions, listened to C-17 stakeholders who might have concerns or suggestions, and when they made a decision, they subsequently supported the consequences of that decision. They provided an excellent illustration of how important leadership is to institute culture change.

In addition to Mr. Koslowski and MGen Kadish, their senior management teams accepted their leadership responsibilities, and aided their employees in learning how to make decisions, coordinating with all stakeholders when an issue arose, and learning how to implement effective integrated process teams (IPTs) within the C-17 program. Training was conducted with all C-17 stakeholders. This included the subcontractors and the DPRO who had not previously been considered to be part of the C-17 team. The message sent by the senior managers on the C-17 program was one of inclusion, not exclusion. This was a departure from the C-17 program history, where organizations had previously been deliberately excluded from meetings. Since IPTs cannot be effective without mutual trust and respect, the culture change fostered by MGen Kadish and Mr. Koslowski was necessary in order to achieve their goal of implementing an effective IPT management structure.

It is important to acknowledge that Mr. Koslowski and MGen Kadish were not the only leaders within the C-17 program. This responsibility was levied on all stakeholders in the C-17 program. For example, Col Mahler (C-17 government head of contracts) and Mr. Ferguson (McDonnell Douglas head of C-17 contracts) demonstrated the same leadership as they worked with the IPT involved with the C-17 contracts. They

established close communication between themselves and required the IPT members to do the same. They reinforced the message of mutual trust and respect and confirmed these principles with their daily actions. These actions were also attributed (by the interviewees) to Mr. Abell (government head of engineering for the C-17 program), Mr. Pantan (deputy of engineering for the government program office) and Mr. Spong (McDonnell-Douglas Senior Vice President for the C-17 program) during the technical meetings. The interview data provided evidence that Mr. Koslowski and MGen Kadish furthered their attitudes along with program objectives through the support of senior level managers. A unified management philosophy was in evidence. Through Mr. Koslowski's and MGen Kadish' initiative, and reinforced at all levels throughout the organizations, the C-17 program was able to change the way its stakeholders conducted business.

In addition to the leadership of Mr. Koslowski, MGen Kadish, and other members of the C-17 IPT structure, two other senior DoD officials were also mentioned frequently for their leadership and advocacy roles. Specifically, Ms. Druyun and Mr. Kaminski, were identified for their assistance to the C-17 program. Ms. Druyun's support of the price reduction efforts and subsequent multi-year contract initiative within DoD and to Congress were considered crucial to their success.

The consistency of management's messages within the C-17 program were reflected during the interviews when the C-17 team members identified the top five issues which contributed to successful economic incentives. The response results are listed in Table 6, with the frequency of the responses for the government and the contractor. This data is based on nineteen interviews.

Contributors	Government	Contractor	Average
Price Reduction and Affordability	100%	90%	95%
Kadish &/or Koslowski	89%	80%	84%
Open Communication & Mutual Trust and Respect	78%	80%	79%
Leadership (not specific)	78%	70%	74%
Joint Cost Team/Exercise	78%	60%	68%

Table 6. Top Five Contributors to Successful Incentives from Interviews

Price reduction and affordability included any references to efforts to reduce the unit price of the C-17 and the implementation of affordability projects to reduce price through process changes. As Table 6 (on page 41) indicates, when discussing the issue of economic incentives, the most common interview responses addressed efforts to reduce the price of the C-17 aircraft.

The designation Kadish and/or Koslowski means a reference to MGen Kadish, Mr. Koslowski, or both of them by name. This is a summary measure, since some C-17 team members referred to MGen Kadish, some talked about Mr. Koslowski, and many of them would refer to "Kadish & Koslowski" as if they were a single entity. This frequency is not a tally of how many times the names were mentioned, but a measure of the number of interviews where they were identified by name at least once. There do not appear to be any obvious patterns by C-17 members as to who talked about MGen Kadish versus Mr. Koslowski, though where they worked affected which program manager they referred to individually. For example, a SPO member from Wright-Patterson AFB was more likely to refer to MGen Kadish, or Kadish & Koslowski, while a McDonnell Douglas employee was more likely to refer to Mr. Koslowski or Kadish & Koslowski. Most of these references were associated with MGen Kadish' and Mr. Koslowski's efforts to move from a position of mistrust, and a troubling relationship between their organizations, to a team effort. Examples were given of how they would conduct joint meetings to discuss issues, and identify the current top ten problems for the C-17 program. Many C-17 team members pointed to these two men as the specific reason for the success of the C-17 program. Their ability to work closely and consistently support each other was noted frequently.

Open communication and mutual trust and respect are grouped together because of the close links and interdependence between the two issues. While the words mutual trust and respect might not be mentioned in an interview, descriptions of open communication were given which included phrases such as "open and honest," "providing reliable information to your counterpart," and "the availability of program forums where teams could bring issues to MGen Kadish and Mr. Koslowski together". These examples

all include aspects of mutual trust and respect, and make it difficult to clearly distinguish between the two issues. If mutual trust and respect was identified alone, the frequency was noted as 56% in government interviews, 70% in contractor interviews, and an average of 63%. These are identical to the frequencies identified with teamwork and forming relationships between government and contractor team members.

Leadership (not specific) refers to discussions concerning the importance of strong, focused leadership for a program like the C-17, but did not directly mention either MGen Kadish or Mr. Koslowski. Leadership also referred to the support of senior defense acquisition officials like Mr. Kaminski and Mrs. Druyun, ASC commander LGen Scofield, and McDonnell Douglas CEO Mr. Stonecipher. Comments were also made which stressed the importance of leaders with no personal agendas. Another characterization of leadership indicated that personality was important in generating team participation for getting solutions to problems discussed and identified.

As shown by its prominence in Table 6 on page 41, members of the C-17 team were aware that the program's vision was to reduce the unit price of the C-17 and increase its affordability while maintaining quality. In addition to this vision, each year Mr. Koslowski and MGen Kadish provided the C-17 team members with the top three program goals for that year.

1. Initial Operational Capability (IOC)
2. Successful completion of reliability & maintainability assessment
3. Defense Acquisition Board (DAB) approval to produce aircraft beyond unit 40

Table 7. Three Major Program Goals for the C-17 Program (1995).

As an example, the top three program goals for 1995 are identified in Table 7. The goal identification was important as a management tool. During program meetings, assessment of any problems always included their impacts upon the program goals. This reinforced the goals' importance to team members and refocused attention on them regularly. The communication of these goals was effective in the C-17 program because they were known by team members from senior management through lower levels such as IPT

members and clerks within the government program office, and production line workers at the contractor's plant.

4.3.3 The Joint Cost Exercise

After working to establish an environment of mutual trust and respect and common goals, MGen Kadish and Mr. Koslowski used one of the acquisition processes known as a joint cost exercise (or should cost) to achieve their vision of price reduction. This exercise was identified by many government team members as the single most important action taken on the C-17 program. In order to convey the importance of the exercise it was run by LGen Scoffield, the commander of Aeronautical Systems Center. In addition, the Inspector General participated as an independent entity with no stake in the final outcome.

The joint cost exercise was important for primarily two reasons. First (1), it established communication and fostered trust and respect among the stakeholders in the C-17 program. By encouraging the participation in the joint cost exercise by government oversight agencies, it allowed the C-17 IPT members to hear the agencies' concerns directly, and allowed the agencies to understand the methodologies involved in establishing the cost estimate. Members of the agencies who felt that they had contributions to make during the estimate were directly involved and could understand how their recommendations were incorporated or could not be applied to this program. A sense of ownership, membership and understanding evolved which involved not only the C-17 program members, but also the governmental agencies' representatives. When questions arose within these agencies, they had an identifiable person within their own organization who could address the issues, or knew who to call for the appropriate information. A network of advocates was developed for the C-17 program.

Second (2), a model was developed which represented agreement among all involved stakeholders on how to implement strategies to reduce the cost of a C-17 aircraft and a numerical estimate of these strategies. The joint cost model which was developed should be viewed not simply as a numerical exercise, but as the codification of many strategies which sought the reduction of cost while maintaining the quality of the C-17

aircraft. Each strategy used to reduce the price of an aircraft was the result of many discussions which required effective communication to reach an agreement. The emergence of the joint cost model signified the success of the cost exercise. To be able to produce a joint cost model which the government and contractor agreed upon, in addition to government oversight agencies, signaled the successful ability of the C-17 stakeholders to communicate effectively and foster agreement. This single achievement contributed significantly to the success of the C-17 program and the ability to identify economic incentives.

The joint cost estimate team's results were incorporated into the annual production contracts for lot 8 and beyond. In order to respond to Mr. Deutch's request in 1995 for the aircraft price per unit for the C-17 program beyond aircraft number 40, the lot 8 negotiations and beyond were commonly referred to as the "buyout" arrangements. (For detail on the C-17 contract, please refer to Appendix A.)

A reader can view the structuring of the FFP and FPIS annual production lots and the changes to the C-17 program structure as a balancing of the government and contractors' risks and rewards. Annual production lots 12 and beyond were structured as FPIS options (only production lots 8-11 were negotiated as FFP options) because of the risk inherent in estimating the status of the C-17 program five years in the future. While the potential reward to the contractor (approximately 18% profit) was to be protected, identifying the target cost of the C-17 aircraft (target price minus profit) was subject to inaccuracy. The FPIS structure of the option allows the possibility of greater or reduced cost reduction without invalidating the approach and philosophy adopted during the joint cost exercise. An FFP structure could have greatly benefited either the contractor or the government depending on the successful implementation of the price reduction strategies. Simply, if greater savings are seen than previously anticipated, then the FFP allows the contractor to realize a greater then 18% profit rate, which is already considered high by certain government standards. If the C-17 program does not achieve all the price reductions it had anticipated, then the contractor would be penalized by a FFP contractual option since it would effectively reduce the profit rate.

Profit rates, though, are not the only risks and rewards to be considered. The six changes to the C-17 program structure listed in Table 8 were necessary in order to implement the strategies for the price reductions identified in the joint cost exercise. Each of these changes needed to be made to accommodate the conditions and groundrules used during the construction of the estimates. The team had been challenged to identify what

(1) Reduced military standards and specifications on contract in favor of performance specifications
(2) Change from full Cost Schedule Control System Criteria (CSCSC) to Cost Funds Status Reports (CFSR) as a result of the change to an FFP contract and having confidence in the C-17 cost and major drivers in the cost model
(3) A greatly reduced Contract Data Requirements List (CDRL)
(4) Changes in the prime contractor's responsibility for tracking suppliers' warranties
(5) Breaking the previously "single" C-17 production contract into three separate contracts (production, logistics/long term support, and PE/PI for producibility enhancements)
(6) Allowing McDonnell-Douglas more configuration control

Table 8. Changes to C-17 Contract.

rules, regulations, or operating procedures, if removed, might provide a reduction in price, and that needed to be built into the contract. Since these items involved removal of several governmental regulations, the issue of "consideration" (returning to the government the value of what it would have paid for those regulations) had to be addressed. Most of the consideration in the C-17 program was accounted for through price reductions. This insured that the government was not assuming more risk for the C-17 program than it already had.

The separation of the single C-17 production contract into three separate contracts, item (5) in Table 8, was a significant step. It allowed the C-17 program to easily identify the production price of a C-17 aircraft, and compare it directly to the

NDAA modified 747 price, without including engineering development and logistics costs which were not part of the NDAA estimate. Prior to the existence of the three contracts, the C-17 program believed that the total contractual price divided by the total number of aircraft artificially inflated the price of a C-17 aircraft (as compared to the NDAA) and did not emphasize cost reduction. The production contract for lot 8 and beyond isolated flyaway costs to the production contract. Separate contracts and Statements of Work were developed for field support and PE/PI. The PE/PI contract directly manages the change process, and field support directly manages the expenses and risks associated with that effort.

In addition to the six items mentioned above, and the FFP and FPIS structure of the annual options, risk mitigating provisions were built into the C-17 production contract in return for the contractor incorporating new estimating tools (that moved away from demonstrated performance) for labor hours associated with the price reduction strategies. The most important of these provisions is the one which was put in place to account for rate fluctuation. As part of the joint cost model developed, a Variation In Quantity (VIQ) matrix was developed. The VIQ matrix acknowledged one of the contractors most important risks - the change to the quantity planned to be purchased for an annual production lot. During the joint cost exercise, the relationships between rate and price were explored and verified. The presence of the VIQ as part of the joint cost model helped to serve two primary purposes. It (1) allowed the government to quickly and accurately answer questions from Congress concerning the funding impact associated with adjusting production rate, and (2) quantified the contractor's risks associated with rate fluctuations. In order to minimize the government's risks associated with these contractual provisions, a "trigger band" was defined by which none of these provisions can be considered in the annual cost negotiations until all of them affect the price by 2%. As one reviews all of the risk and reward balances which were identified, discussed and agreed upon, it becomes clear why it took two years of effort to award the lot 8 contract in 1996.

When the discussion concerning the possibility of a multi-year contract for the C-17 program arose, McDonnell Douglas quickly identified the risk of assuming an

additional 10% price reduction (traditional government guidelines for awarding a multi-year contract) as too large. After significant discussion of the risks to both the contractor and government, an agreement was reached. It involved a 5.5% price reduction, performance based payments and funding of Economic Order Quantity (EOQ) money. The EOQ money is considered by the government to be a substantial economic incentive to reduce unit price. The government funded EOQ for investment in affordability cost reduction projects. The combination of early liquidation of EOQ funding and the performance based payment financing equivalent to 100% progress payments helps to increase cash flow for the contractor. Also, several terms and conditions are included in the multi-year contract to limit potential financial risks to the contractor. These include a pre-exercise option adjustments clause and a program discontinuation clause.

It is important to acknowledge that the economic incentives to the contractor in the annual production lot contract or the multi-year contract (performance based payments, approximately 18% profit, four years of FFP annual contractual options, constraints on rate fluctuations) were derived from the work started in the joint cost exercise, but were not fully defined there. They were identified and agreed upon during the complicated negotiations leading to the lot 8 buyout arrangement. These incentives were not defined through regulations, but by the stakeholders of the C-17 program. Each of the incentives is specific to the risks identified within the C-17 program, and is intricately linked to price reduction strategies and contingencies for future conditions. They were not randomly generated, but required significant effort (the most influential processes, included the joint cost exercise and the contractual negotiations).

Chapter 5: Analysis of Case Studies

The framework in Figure 2 provides a structure to review how the case studies generated economic incentives. While economic incentives are not identified as an individual step in the process flow, they are a product of the process step identified as the development of the program risk mitigation plan.

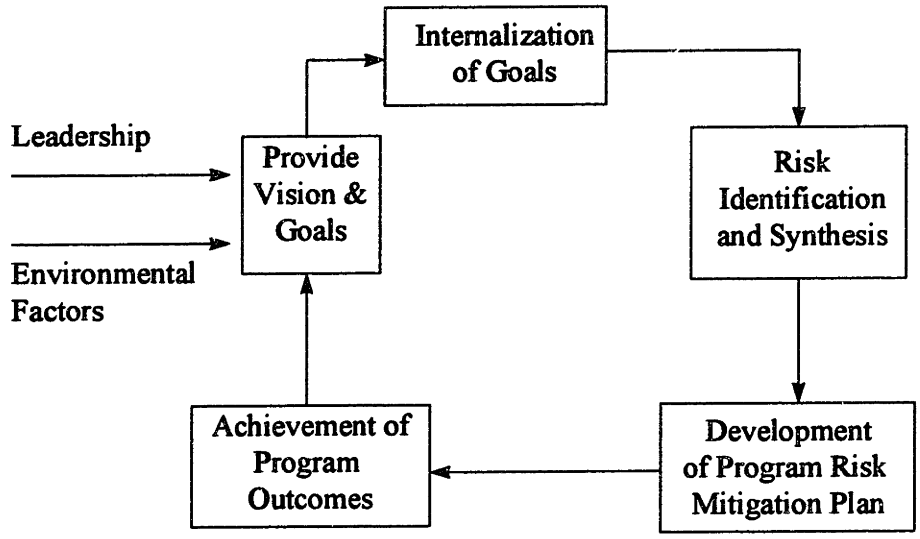

Figure 2. Framework to View Process Flow Which Generates Economic Incentives.

This process pictured in the framework involves a "flowing down" of each program's vision and goals from the highest levels of management to each team member (first two steps in the process - Provide Vision & Goals and Internalization of Goals), and then a "bottom's up" synthesis of the risks associated with the vision and goals of the weapon system program (next process step - Risk Identification and Synthesis). From this "top down" goal assimilation and "bottom's up" risk identification, the case study programs were able to carefully develop a Program Risk Mitigation Plan particular to their situation. It is during this step of the process (Development of Program Risk Mitigation Plan) where specific economic incentives corresponding to the program risks can be

developed to encourage certain types of behavior. They can be structured as part of the Program's Mitigation Plan and used to address specific risks. Economic incentives can be viewed as a product of this step of the process. The Mitigation plan will then enable a program to achieve their desired outcomes, as shown in the next step.

The process is continuous, and does not end with the achievement of any given program outcome. Since a weapon system acquisition program matures and changes, this process must continues as goals change within each program. It is this link which ties the management process with the incentives on contract, and is dynamic and continuous within a weapon system procurement program. Risks might change, thus requiring an update of the risk mitigation plan (i.e. a change to only one step in the process) or the program goals may change with time and each step within the process must be performed again in sequence to identify updated goals and risks, and new economic incentives to achieve the program outcomes.

There are several specific traits of this process flow which should be noted. The inputs to this process have been labeled environmental factors and leadership (as discussed in the prior chapter as actions attributed to MGen Kadish and Mr. Koslowski in the C-17 program, and the program managers in the munitions programs). The distinction between these two, is that the leadership actions were within the control of the weapon system's program management and their superiors, while the environmental factors were outside of their control. While the environmental factors cannot be directly attributed to the actions of the program management, they greatly influenced the process and its outcomes and cannot be discounted.

5.1 Process Inputs

There are several influencing factors which can be viewed as inputs to the process. While there are many actions which could be considered inputs, the ones identified are those which most affected the process and its outcomes. These inputs have been categorized as either leadership or environmental factors.

5.1.1 Leadership

As stated previously, leadership is determined by the actions of the program managers. Appointing MGen Kadish and Mr. Koslowski as the Air Force and contractor program managers, can be considered an input to the C-17 process used to establish economic incentives. Similarly, the program managers appointed by the government for Munitions Programs I & II can be included as leadership inputs. The actions of Mr. Jones, Mr. Cox and Mr. Taylor on the C-130J program can also be labeled leadership inputs. This input refers to the ability to point to specific manager who had direct influences on team members and, as a result, affected the program outcomes.

Leadership also refers to the support of senior acquisition officials and contractor management. One of the common threads running through all four of the case studies is the involvement of Mrs. Druyun and other senior government officials to help support program initiatives.

5.1.2 Environmental Factors

One of the inputs to the process has been identified as environmental factors, or those actions which are or were not under the control of program managers. On the C-17 program there were three primary environmental factors. They are shown in Table 9,

1. Stabilization of the C-17 aircraft design.
2. Competition of the NDAA program.
3. The Omnibus negotiated settlement.

Table 9. Environmental Factors.

and discussed in Chapter Four with the history of the C-17 program. Each of these factors had a direct effect upon the C-17 program's success and the ability to complete the process shown in Figure 2 on page 49. In the Munitions I case, the end of the Cold War can be considered an environmental factor, since the decision to change the production from 20,000 to 5,000 units was not with the control of the program management. In the Munitions II program, new acquisition policies and the pilot program designation allowed

for actions the program managers could not authorize, and in the C-130J program, the long C-130 history and the passage of FASA are considered environmental factors.

5.2 Provide Vision & Goals

Providing vision and goals includes the decisions by the program managers in each of the case studies to foster an attitude of mutual trust and respect within their programs, and encouraging open and honest communication. It is important to note that this does not mandate a team oriented organization with a fully participative management style. Each program manager must use a management style which is comfortable for them, and allows effective information flow and communication.

In the Munitions I and C-130J case studies, while teams had been set up for certain tasks, information flow within the contractor's plant was controlled primarily by the program manager, unlike the free information flow among teams within the Munitions II and C-17 case studies.

In either type of management style, evidence from the interviews suggests that the program members in both the contractor and government offices agreed upon the main objectives for the program and were working toward the same goals. In Table 10, the goals for each of the four case studies are summarized.

Munitions I	Unit Price Reduction for Affordability
Munitions II	AUPP metric
C-130J	Minimize cost of ownership Commercial practice adoption
C-17	Unit price reduction Top Three Annual Goals

Table 10. Case Study Program Goals.

5.3 Internalization of Goals

In this step of the process, the program goals are understood and adopted by all of the stakeholders within each of the weapon systems programs. Tasks are identified by

team members at all levels of the organization which contribute directly to the ability to achieve the program goals. Objectives are set by each team member which they must achieve to ensure program success. Communication among team members is important to ensure that objectives and tasks set by team members are not in conflict. These actions are the "flow down" of the vision and goals to each individual team member on the program. This step of the process is a critical precursor to the risk identification each team member performs in the next step of the process. If the vision and goals are not well understood, or broken down to the activities each team member performs, the identification of risks can be incomplete and inaccurate. The evidence of this steps occurs when the flow of information is seen to move to the lowest levels of the contractor and government organizations, where this information is needed to plan the execution of future work. With the planning of future work, risks are identified, and can then be analyzed.

All of the groups in the four case studies relied upon IPTs to aid the flow of information between government to contractor stakeholders. The Munitions II and the C-17 program relied on the IPT process to ensure communication among team members within the contractors organization and government organization to help accomplish the "flowing down" of the vision and goals to all levels within the teams. The Munition I program relied upon established contractor information channels and small teams formed to achieve specific goals for information flow. The Munitions I government program office was small enough (10-15 people) that a weekly staff meeting and informal communication allowed for the information flow needed to keep the SPO aware of current issues and to refocus on program objectives. Mr. Jones relied upon weekly staff meetings and the communication between his functional organizations and managers to convey the information necessary to company employees, though evidence of information flow between the contractor and the government was in question.

5.4 Risk Identification and Synthesis

The knowledge necessary to each program's success is resident in the people who compose the team. Every member of each program weapon system team brings a specific set of skills and knowledge to their job. It is the sum of all this knowledge and capability

which allows the program to achieve its success. Since critical pieces of knowledge, skill and information are resident in individual team members, the risk to the program must start with each person identifying risks to their objectives and tasks. Since expertise occurs on an individual level, risk identification must be initiated on that level. Each team member translates their objectives (derived from program goals) to risks which they must manage. At this step, the ability to communicate and move information easily among team members allows for a more effective risk evaluation. Communication will enable team members to make more informed decisions.

Once each team member starts to identify the risks which they must manage to accomplish their tasks, these risks can then be collected and synthesized at higher levels within teams or through organizational hierarchy. IPTs and functional organizations can identify and prioritize the risks within the program. Careful management will ensure that a thorough risk assessment of the entire program is performed. Communication, again, is essential in order to avoid misunderstandings and the potential of overlooking certain risks.

The use of teams by all four programs is one of the ways to allow questions to arise concerning the implication of certain risks. The C-130J contractor appeared to rely more on the functional organization within the contractor's plant to handle questions, while teams are formed between government team members and key contractor management personnel. The Munitions I program is moving away from this type of organization and working to implement true IPT arrangements to handle communication and program questions and risks. Munitions II, like the C-17, used the IPT structure to identify issues and concerns. The environment of mutual trust and respect created by MGen Kadish and Mr. Koslowski enabled C-17 team members to feel comfortable pointing out potential problems and asking questions in order to identify possible misunderstandings. The joint cost exercise can be also considered one of the methods the C-17 program used to perform this synthesis of risk.

5.5 Development of Program Risk Mitigation Plan

Once the program risks have been identified, management decisions can be made concerning applying the resources necessary to reduce certain risks. Resource shortages will be identified, and strategies for addressing the shortages can be agreed upon. It is this step where the balancing of the risks against potential rewards occurs and potential economic incentives can develop. The incentives will be results of the mitigation plan which aid in the accomplishment of the final step - achievement of program outcomes.

5.6 Achievement of Program Outcomes

These are the outcomes expressed in the PMD. They can be meeting requirements, price reduction, certain levels of returns based upon existing business base, shared benefits from technology or process improvements, or any number of other desired outcomes. They relate back to the vision and goals established by the program's management, and the ability to achieve the desired results. This link make this process a dynamic, continuous process within each program.

5.7 Discussion of Incentives Present in Case Studies

In one sense, incentives can be viewed as enablers; tools which allow successful achievement of the program outcomes. They are also the formal contractual agreements for handling risk compensation.

While each of the four case studies identifies numerous contractual clauses they consider to be incentives, they can be categorized as one of two types. They are either financial (i.e. profit rates, investment reimbursement, share ratios) or bureaucratic. While bureaucratic incentives can lead to reduced overhead, smaller staff, and other reasons for cost savings, they are implemented primarily to reduce time spent meeting bureaucratic requirements, and verifying they've been met. Table 11 on the next page identifies examples of these incentives for each program.

The financial incentives award monetary amounts for achieving certain targets or allow financial limits on liabilities like warranties. They are usually settled during negotiations which look specifically at the contractor and the government's risks, and attempt to balance financial rewards the contractor receives for assuming an agreed upon

Program	Financial Incentives	Bureaucratic Incentives
Munitions I	• Increased profit rate • Limited financial liability for warranty • 50/50 share ratio • Investment reimbursement	• Performance specs • Configuration control
Munitions II	• AUPP • FFP annual contracts	• Pilot Program • TINA waiver • Performance specs
C-130J	• Profit rate not specified • ROI (contractor $)	• Commercial item contract
C-17	• Profit rates • EOQ investment money • Multi-year contract • Award Fee • Future liability limits	• Performance specs • Configuration control

Table 11. Examples of Incentive Types for Case Study Programs.

amount of risk in the program.

Bureaucratic incentives are different. They refer to relief from regulations, specification, warranties, regulation waivers, oversight exception, and any other arrangement which relieves the contractor from perceived responsibilities to some organization within the acquisition system. Bureaucratic incentives could be an indication that the acquisition process is not functioning properly, and additional changes need to be made as part of acquisition reform policies. It could also indicate that changes which are part of acquisition reform policies may not be implemented similarly at each weapon system product center.

To further define bureaucratic incentives, members of the C-17 team identified barriers and enablers they felt they faced when trying to develop economic incentives.

Because of the large number of interviews on the C-17 case study, these barriers and enablers can be categorized with the frequency with which they were discussed. If a topic's potential impact upon successful economic incentives, or the process leading to incentives is positive, then it was considered an enabler. If the agreed upon potential impact is negative, then it was considered a barrier. They are listed in below in Table 12.

Barriers and Enablers	Government	Contractor
Barrier and Enabler		
Acquisition Reform	67%	30%
Enablers		
Joint Cost Model	78%	30%
Barriers		
Changing Budgets	44%	30%
Oversight	44%	30%
Fair & Reasonable Determination	44%	10%
Colors of Money	22%	30%
Profit	44%	10%
Air Force Spares System	22%	10%

Table 12. Barriers and Enablers Identified in C-17 Interviews

Acquisition reform measures were identified as both a barrier and an enabler by different C-17 team members. As an enabler, it allowed the removal of numerous military specifications and regulations during the lot 8 contract negotiations. Many of these contributed to the ability to reduce the unit price. It also allowed the contractor more flexibility within the configuration control system. On the other hand, several members of the C-17 SPO pointed out that most of the reform measures concentrate on the relationship between the contractor and the SPO. They suggested that effort be focused on the relationships between governmental offices. There did not appear to be any reform efforts affecting the relationship between the SPO and its higher headquarters during

approval processes. They stated that there did not appear to be any efforts concentrating on how to eliminate certain reviews, meetings or paperwork needed for higher headquarters. This was considered to be a barrier to implementing changes. It was also pointed out that the relationships between Congress and the DoD and the DoD and the Department of the Air Force could use reform.

Another concern associated with acquisition reform raised by the contractor was that future competitions could be scored up to one half of the total based upon past performance. While this seems like a good idea, its implementation raises numerous concerns among contractors. They felt that this was a barrier to establishing trust.

The joint cost model, the numerical results of the joint cost exercise, enabled the establishment of many of the incentives for the lot 8 contract and the subsequent multiyear contract. It was identified as extremely useful especially by the contracts and financial IPT members. The model, as an enabler, appeared to be more useful to team members within certain functional areas, while the exercise itself affected team members across all disciplines.

Changing budgets affect a contractor's ability to plan for the long term. They increase risk, and minimize contractor investment in affordability projects to redefine processes. They act as barriers to investments which require longer time periods to realize returns.

Oversight activities increase the workload for government and contractor C-17 team members. Specifically, the GAO was identified as one oversight organization which was extremely difficult to work with, especially prior to the joint cost exercise. An example was given where the contractor worked closely with the local GAO office and on-sight personnel, but the GAO's final report did not reflect anything which had previously been put in writing and reviewed in draft form.

The determination of what is fair and reasonable is a concern emphasized at all levels of the government. Unfortunately, determining what is fair and reasonable can be affected by each individual's personal experiences. Government contracting officers feel as though they must continually defend their decisions to anyone who might question it.

The color of money refers to the government's categorization of the type of work tasks which funding can be authorized for. For example, 3600 money (research and development funds) cannot be applied to operational costs or the purchase of spares. In addition to being concerned about having the correct amount of money in the budget, the contracting officer must make sure it's of the right type also.

Profit is one of the concerns of government employees, because profit levels receive significant attention in the review process for a new contract. One government employee stated that being a steward of the taxpayers' money is not congruent with the contractor's desire to maximize profit. This common government attitude can be seen as a short-sighted approach to creating economic incentives.

The spares system is considered a barrier because it is independent of the development of the aircraft. Further unit price decreases have been identified based upon a different contractor supplied logistics system.

Each of these barriers and enablers can contribute or inhibit the design of economic incentives specific to each program. As mentioned, several of these issues are of great concern to government contracting officers who feel as though the acquisition system does not encourage them to use innovative solutions to contractual problems.

5.8 Comparison of Case Studies

As one studies the analysis of the Munitions I and II and C-17 case studies, similarities and differences emerge. The similar attributes are:

- Effective lean leadership
- Use of IPT structures
- Mutual trust and respect
- Agreed upon goals
- Common cost understanding and agreement (use of some type of cost model)

The similar program outcomes are:

- Implied long term US Air Force commitment
- Contractor commitment to invest to become leaner
- Projected reduction in price per unit

- Risk dealt with successfully
- Financial and performance goals achieved

5.8.1 Importance of Similarities

One of the points identified by team members during interviews was the ability to discuss any subject necessary. While this seems to be simple, it can become difficult quickly in the world of defense acquisition. There are several important management issues at the heart of this simplicity. One is the relationship between the contractor and their Air Force program office. If a certain measure of trust and respect do not exist, certain extremely complicated issues seem to be almost impossible to solve (for example, overhead rate negotiations and their effect on profit, future budget commitments leading to production rate issues, the technical problems seen on the C-17 program, etc.). The development of this trust and respect was mentioned in three of the four case studies as an item management emphasized. Specifically, the Air Force program director and the contractor's counterpart were the key management examples looked to by the team members. If these two individuals set an example of close cooperation, trust, and constant communication, they appeared to have an influence on the people working for them.

Another management issue that appeared to affect communication was the organizational structures of the Air Force program office and their prime contractor. The program offices which implemented successful (and sometimes innovative) economic incentives stated that they set up IPTs made up of members of the Air Force and contractor offices, and sometimes other outside agencies. This is not to state that forming IPTs means success at defining economic incentives. The evidence cannot support that conclusion. When comparing the program offices, it was noted that one had a more traditional Air Force structure, organized along the lines of functional responsibilities, while two were organized along the lines of integrated product development teams. One of these structures does not appear to hold an advantage over the other. They both exhibited close working relationships between the Air Force and contractor personnel, with apparently open lines of communication.

What appears to be the important aspect about the IPTs, is the creation of a working environment and relationship where the ability to communicate is encouraged or accepted. In the four case studies, team members stated that the military and contractor program directors encouraged discussion of any topic that was of concern. These included problems that might not be under the control of either organization (i.e., overhead rates, audits, higher headquarters approval processes). Potential solutions to the problems were open for discussion, and people were encouraged to identify participants in other organizations that might be able to help them solve their problems. The teams also stated that problems were not allowed to "fester" at the IPT level. If the IPT could not work out a solution quickly (the definition of quickly appeared to be dependent upon each issue), then the program directors would discuss it and identify how they intended to reach a solution. Not only was communication between the Air Force and the contractor open and swift, communication among the management levels within each organization was candid and expeditious.

5.8.2 Importance of Differences

The different attributes are:

- Perception of program goals by government and contractor
- Risk-reward ratio
- Program management styles
- Use of cost and pricing data (TINA)
- Relationship between prime contractor and suppliers and subcontractors

The differing program outcomes are:

- Different incentives in each contract
- How cost savings were shared, reinvested, or returned to the government

The relationship between the C-130J contractor and AF SPO was not characterized in the same manner by the two parties. The contract and incentives described by the contractor are identified as incentives to the contractor, though the AF

does not share these perception. This is evidence that agreement among program goals does not exist.

One of the examples of how the risk-reward ratio differed was in the area of warranties. Among the four programs, one has an unlimited warranty typical of some of the recent changes in the DoD's policy on warranties, and the other three have some type of liability limit imposed These programs also happened to start development under earlier DoD policies on warranties and risk assumption. In order to allow changes, and not overly expose the company to financial and technical risks it hadn't built into its design phase, the warranty has financial limits imposed on it.

With 60-75% of the effort subcontracted, management of suppliers was significant on the part of the prime contractors. Each prime usually had FFP contracts with its subcontractors. Two primes did not flow any of their incentives (incentive fees, award fees, etc.) to its subcontractors, while the other two primes had negotiated rather complex incentive and pricing arrangements with some of their subcontractors. The primes with no incentive arrangements were working towards forming long term relationships with its primary suppliers, though the situation for the C-130J program has significant differences due to the commercial item designation and the need for offsets in foreign countries when purchasing aircraft. All contractors identified a difference between suppliers and subcontractors who are supplying a rather standard part, and the defense work is only a small part of their business, contrasted against a contractor who performs highly specialized production which is a larger percentage of its overall business. These two situations appear to provide differing boundaries for structuring contractual and incentive relationships.

Chapter 6: Conclusion

The case studies identify several steps in the process toward determining the appropriate economic incentives for a program. These include:

- Leadership and use of IPTs within the programs helped to increase communication and the flow of information to overcome the information asymmetries associated with principal-agent relationships.
- Mutual trust and respect and effective communication are enablers to the internalization of high level strategic milestones, program goals and visions.
- Once goals are communicated, program risks must be assessed before incentives are developed.
- Economic incentives are the result of negotiations which involve the delicate balancing of risks and rewards for both the contractor and the government.
- Economic incentives involve program specific conditions.
- Structured financial incentives are difficult to implement without an agreed upon cost model for a program.
- While the C-17 multi-year contract reduced unit price by 5.5%, it does not appear that resolving the conflict of cost and quality can only be done through multi-year arrangements. The significant price reduction associated with the Lot 8 buyout arrangement suggests that advantages can be gained through annual production lots. This is confirmed through cost savings gained in the Munitions I & II programs which use annual production contracts.

From the initial interviews, in addition to the emerging barriers, enablers, and metrics previously discussed, two other conclusions were made. In all the interviews, participants were asked to identify programs they believed exhibited characteristics of successful incentives. While numerous examples exist where a specific type of clause, or incentive was used beneficially, it was very difficult to find programs where numerous examples were used, or several approaches were used simultaneously. The first

conclusion was that that there is little predisposition in the present system to support or use all of the currently available acquisition policies, processes and procedures.

A second conclusion drawn from the initial interviews was that, on the government side, there is a concern about the policies, processes and procedures used when assembling a contract. Anything which deviates from standard contractual terminology (as defined by senior government contracting officers) requires significant amounts of time, the willingness to take risks and the ability to withstand pain in order to secure approval through many levels of governmental bureaucracy. The resistance to the use of new or different contracting techniques occurs because government contracting officers are extremely worried about future retribution for the decisions they make. Almost all of the contracting officers pointed to the "firing" of four senior officials associated with the C-17 program as a potential outcome of taking too many risks. It is important to note that when asked to define what they fear, most of these people identified offices or personnel as threats which were in the higher headquarters or Pentagon. The threat resides between the implementers of policy - the contracting officers in the program offices at ASC, and the policy makers at the highest levels of DoD and the Air Force. This implies that there are problems with policy implementation within the Air Force acquisition system.

This information poses specific policy recommendation for program managers within weapon system programs. The process flow identified in Figure 3 at the beginning of Chapter 5 identifies the importance of communicating the vision and goals of a program to all team members. If team members are not clear to the program goals, the risks may not be assessed correctly within any given program. The use of IPTs can be an important tool for managers to use when attempting to convey this information to all team members. Government officials should review methods of team building to be used in conjunction with oversight mandated by regulations to reduce informational asymmetries. A future analysis of the success of the Munitions II program can point to areas in which oversight can be removed.

Since the four program were able to more clearly structure financial incentives after developing an agreed upon cost model, program mangers should identify

opportunities at the end of development and at several points in production where a cost model can be generated and then updated. While many programs do not perform a should cost exercise as comprehensive as the C-17's joint cost exercise, the government and the contractor need a point of common understanding when reviewing the financial position of a weapon system program. The accepted cost model in the Munitions II program was generated by the contractor as part of the competition, and agreed to by the government. Financial performance (and the success or failure of incentives) can then be evaluated from a common reference point or condition.

Once incentives are established on a contract, they must be in agreement with the program's goals, or they can be ineffective. A program manager must update incentives as goals change. For example, if the C-17 program were to change the program goal from affordability to technology insertion, then the incentives in the multi-year contract would require review. The FPIS arrangements could prove ineffective given a different set of program goals, and cost reimbursement incentives would be more appropriate to generate contractor investment for new technologies.

Due to the stiff competition within the DoD for funding, affordability appears to be a common goal for weapon system procurement programs. The structure of financial incentives on programs to encourage affordability differed, though, among the four case studies. The C-17 program did not structure an FFP arrangement like the Munitions II AUPP because of the much larger dollar value of the risks assumed. A program manager must assess the type of incentives feasible for their program's contract given the dollar amount at risk. The incentives chosen for each program must agree with the program's goals, and survive the yearly budget approval process. As the C-17 program establishes several years of correlation of actual production prices against their cost model and contract structure, the ability to predict future unit price with a higher degree of certainty could allow the structuring of future FFP contracts which would provide the contractor additional incentive to underrrun.

This thesis provided a framework for government and contractor program managers to develop economic incentives. Changing acquisition policies offer interesting challenges for program managers as they attempt to structure procurement contracts

which meet government and company goals and objectives. The framework developed highlights the critical link between the management processes within a weapon system acquisition program and the establishment of economic incentives. Practices are described which help identify, quantify and foster the development of incentives.

The case studies also identified certain enablers and barriers to the establishment of these incentives. The enablers included:

- Open communication, mutual trust and respect,
- Should cost exercises,
- Lean leadership,
- Integrated process teams, and
- Acquisition reform policies (also a barrier).

The barriers included:

- Instability of funding,
- Non-value added oversight,
- Color of money,
- AF spares system, and
- Acquisition reform policies (also an enabler.)

The case studies provide evidence that economic incentives are possible in today's procurement environment. The case studies performed captured the programs at specific points of implementing their incentives (especially the C-17 program at the start of their multi-year contract). Further study of the performance of the government and contractor with the incentives is recommended in order to assess the effectiveness of the incentives implemented.

Appendix A - Case Study Contract Details

C-130J Contract Details

The contract period of performance includes FY 1996 - FY 2000, with aircraft deliveries in calendar years 1997 - 2001. Each fiscal year is a firm priced option which allows the government to purchase from 1 to 32 aircraft in that year. The government price of aircraft is based upon a production base of 12 international aircraft sales and 12 government aircraft per year. The production rate for 1996 of 17 aircraft per year is the lowest rate the production line has ever experienced.

The C-130J system warranty provision consists of three parts:

•Part A - 12 month or 1000 flying hours basic warranty after government acceptance.

•Part B - Extended supplier warranty up to five years on some avionics components.

•Part C - Structural Service Life warranty of 30 years up to a cap of $1.75M.

The contract terms and conditions for the C-130J are in accordance with FAR 52.212-4, and contain only the provisions noted in Table 13.

Inspection/Acceptance (tailored)	Invoice	Taxes
Assignments	Patent Indemnity	Limitation of Liability
Changes (tailored)	Payment	Other Compliances
Disputes	Risk of Loss	Order of Precedence
Definitions	Termination	Warranty (tailored)
Excusable Delays	Title	

Table 13. Provisions in C-130J Commercial Item Contract.

C-17 Contract Details

After the joint cost exercise, Lots 8, 9, 10 and 11 were negotiated with firm fixed price (FFP) options with profit rates around 18%, while lot 12 and beyond were designated as fixed price incentive, successive (FPIS) options. These were successive target cost arrangements, where the minimum and maximum profits (up to approximately 18%) were pre-determined along with a target cost. (See Figure 3.) Each option, before it was to be exercised, would be negotiated within the parameters already determined, figuring in current unit costs. The option would then be converted to a FFP contractual clause. Costs will be negotiated using the agreed upon cost model, and were intended to fall within the designated target range. If the cost was within the target range as expected, the contractor would earn a profit amount between the designated minimum and maximum amount. If the cost is less than the amount in the target range, the contractor would receive the maximum profit amount, while if the cost is greater than the amount in the target range, the company received the

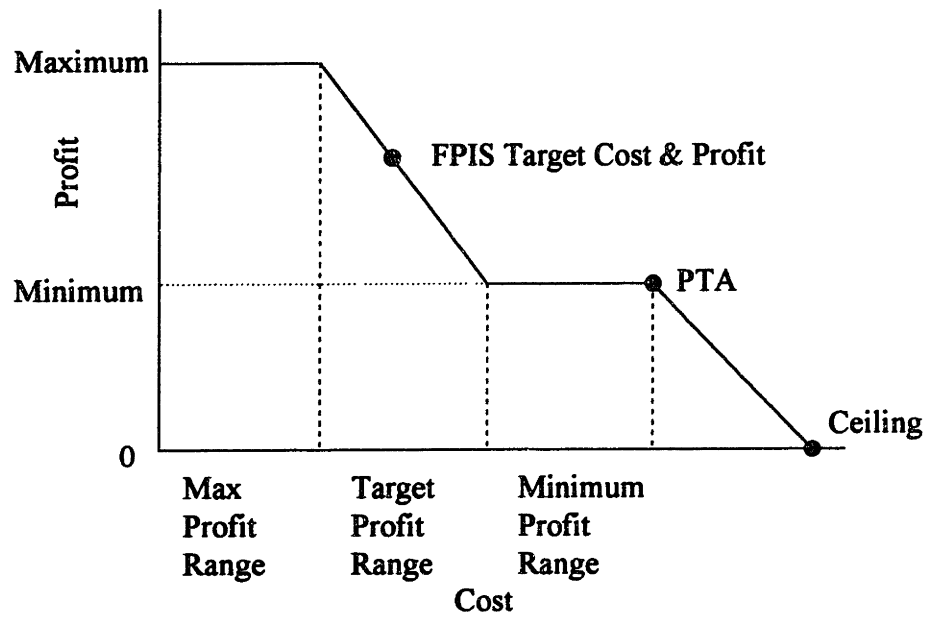

Figure 3. Structure of FPIS Options

minimum amount of profit. A share line of 70/30 occurred between minimum and maximum profits. As the cost exceeds the point of total assumption (PTA) and moves toward the ceiling cost, the contractor's profit goes toward zero. The purpose of this structure was to mitigate the risk of taking away profits and potential gains from the contractor by making the annual negotiations based upon costs only.

Other changes to the C-17 program structure incorporated into lot 8 (derived from the joint cost exercise) were (1) reduced military standards and specifications on contract in favor of performance specifications, (2) change from full Cost Schedule Control System Criteria (CSCSC) to Cost Funds Status Reports (CFSR) as a result of the change to an FFP contract and having confidence in the C-17 cost and major drivers in the cost model, (3) a greatly reduced Contract Data Requirements List (CDRL), (4) changes in the prime contractor's responsibility for tracking suppliers' warranties, (5) breaking the previously "single" C-17 production contract into three separate contracts (production, logistics/long term support, and PE/PI for producibility enhancements) and (6) allowing McDonnell-Douglas more configuration control. Originally, the government had intended to conduct Physical Configuration Audits (PCAs) and Functional Configuration Audits (FCAs) to incorporate Class II (those which do not affect form, fit or function of the aircraft, and are traditionally under contractor control) configuration changes. The updated Configuration Management Plan for lot 8 and beyond identified three classes of changes. The traditional Class I changes, those which affect form, fit or function, were fully incorporated into the price of each lot of aircraft, and not left for future determination. Class III changes were identified as a means of implementing Class II changes which had retrofit impacts. Class II and Class III changes were not priced as part of the contract and were left under control of the contractor.

References

1. Comptroller General, "Acquisition of Major Weapon Systems," Department of Defense Report B163058, July 1972, and "Inaccuracy of Department of Defense Weapons Acquisition Cost Estimates," House Committee on Government Operations, November 16, 1979.
2. Jacques S. Gansler, *Affording Defense*, Cambridge, MA, 1989.
3. Jean-Jacques Laffont and Jean Tirole, *A Theory of Incentives in Procurement and Regulation*, Cambridge, MA, 1993.
4. Dominique B. Meyers, D. Colleen Griffith, Mark D. Bennington, Carol E. White, and Debra Haller, "Use of Commercial Practices Helps Streamline A Complex Acquisition," *Contract Management*, November 1995.

Bibliography

Adams, Gordon, *The Politics of Defense Contracting, The Iron Triangle*, Transaction Books, 1981 (by the Council on Economic Priorities).

Aghion, Philippe and Jean Tirole, *The Quarterly Journal of Economics*, "The Management of Innovation," November, 1994, pp. 1185 - 1209.

Alic, John A., Lewis M. Branscomb, Harvey Brooks, Ashton B. Carter, and Gerald L. Epstein, *Beyond Spinoff: Military and Commercial Technologies in a Changing World*, Harvard Business School Press, 1992.

Bower, Anthony G. and James N. Dertouzos (eds.), *Essays in the Economics of Procurement*, RAND, 1994.

Bower, Anthony G. and Steven Garber, *Statistical Forecasting of Bankruptcy of Defense Contractors: Problems and Prospects*, RAND Report MR-410-AF, 1994.

Bower, Anthony G. and Kent Osband, *RAND Journal of Economics*, "When More is Less: Defense Profit Policy in a Competitive Environment," Vol. 22, No. 1, Spring 1991, pp. 107 - 119.

Branscomb, Lewis (ed.), *Empowering Technology: Implementing a U.S. Strategy*, MIT Press, 1993.

Cook, Thomas D. and Donald T. Campbell, *Quasi-Experimentation: Design and Anlaysis for Field Settings*, Houghton Mifflin Company, 1979.

Coopers & Lybrand and TASC, *The DoD Regulatory Cost Premium: A Quantitative Assessment*, December 1994.

Crocker, Keith J. and Kenneth J. Reynolds, *RAND Journal of Economics*, "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement," Vol. 24, No. 1, Spring 1993, pp. 126 - 146.

Drezner, Jeffrey A., Giles K. Smith, Lucille E. Horgan, Curt Rogers, and Rachel Schmidt, *Maintaining Future Military Aircraft Design Capabilty*, RAND Report R-4199-AF, 1992.

Fox, J. Ronald, *Arming America: How the U.S. Buys Weapons*, Harvard University Press, 1974.

Frazier, Thomas P., Matthew S. Goldberg and Thomas R. Gulledge, Jr., *DoD Profit Policy and Capital Investment in the Military Aircraft Industry*, IDA, IDA Paper P-2359, March 1990.

Friedman, Milton & Rose, *Free to Choose*, Harcourt Brace & Company, 1990.

Gansler, Jacques S., *Affording Defense*, MIT Press, 1989.

Gansler, Jacques S., *Defense Conversion*, MIT Press, 1996.

Gorgol, John Francis, *The Military-Industrial Firm: A Practical Theory and Model*, Praeger Publishers, 1972.

Graham-Moore, Brian and Timothy L. Ross, *Gainsharing: Plans for Improving Performance*, The Bureau of National Affairs, 1990.

Greene, William H., *Econometric Analysis*, Macmillan Publishing Company, 1990.

Gregory, William H., *The Defense Procurement Mess*, Lexington Books, 1989.

Gregory, William H., *The Price of Peace: The Future of the Defense Industry and High Technology in a Post-Cold War World*, Lexington Books, 1993.

Gulledge, Thomas R., Jr., and Norman K. Womer, *The Economics of Made-to-Order Production*, Springer-Verlag, 1986.

Laffont, Jean-Jacques and Jean Tirole, *Quarterly Journal of Economics*, "The Politics of Government Decision-Making: A Theory of Regulatory Capture," November, 1991, pp. 1089 - 1127.

Laffont, Jean-Jacques and Jean Tirole, *A Theory of Incentives in Procurement and Regulation*, MIT Press, 1993.

Milgrom, Paul and John Roberts, *Economics, Organization and Management*, Prentice-Hall, Inc., 1992.

Milgrom, Paul and John Roberts, "The Economics of Modern Manufacturing: Technology, Strategy, and Organization," *American Economic Review*, Volume 80, June 1990, pp. 1255 - 1277.

Mintz, Alex (ed.), *The Political Economy of Military Spending in the United States*, Routledge, 1992.

Nicholson, Walter, *Microeconomic Theory. Basic Principles and Extensions, 6th ed.*, The Dryden Press, 1995.

Peck, Merton J. and Frederic M. Scherer, *The Weapons Acquisition Process: An Economic Analysis*, Harvard University Press, 1962.

Rogerson, William P., *An Economic Framework for Analyzing DoD Profit Policy*, RAND, R-3860-P&AE, 1992.

Rogerson, William P., *Overhead Allocation and Incentives for Cost Minimization in Defense Procurement*, RAND, R-4013-P&AE, 1992.

Scherer, Frederic M., *The Weapons Acquisition Process: Economic Incentives*, Harvard University Press, 1964.

Schmidt, Rachel, *Defense Profit Policy and Capital Investment*, RAND Graduate School Dissertation, 1993.

Wolf, Charles, *Markets or Governments: Choosing Between Imperfect Alternatives*, RAND, 1993.

Yin, Robert K., *Case Study Research: Design and Methods, Second Edition*, SAGE Publications, 1994.

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