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A CASE STUDY OF THE TEAMING CONCEPT IN THE PROCUREMENT OF THE V-22 AIRCRAFT

by

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December, 1994

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This thesis is a case study of the V-22 Osprey program. It examines dual-sourcing of major weapon systems which was the original acquisition strategy for the V-22. It examines the history of the V-22 program management. The chronology of the program is presented from the birth of the Joint Services Aircraft Program in 1981 through the engineering, manufacturing and development phase in 1994. The focus of this thesis is to look at the relationship between the Jont Program Office, the parent companies of Bell Helicopter, Inc. and Boeing Helicopter, Inc., and the Government. The thesis also looks at other strategies that have been used in major weapon systems procurements such as the F/A-18 aircraft program which is being procured sole-source with the prime/subcontractor arrangement. This thesis concludes that the acquisition of the V-22 has not been efficient and that Bell and Boeing Aircraft Companies, operating under a teaming concept, have not presented a single face to the Government.

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A CASE STUDY OF THE TEAMING CONCEPT IN THE PROCUREMENT OF THE V-22 AIRCRAFT

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ABSTRACT

This thesis is a case study of the V-22 Osprey program. It examines dual-sourcing of major weapon systems which was the original acquisition strategy for the V-22. It examines the history of the V-22 program management. The chronology of the program is presented from the birth of the Joint Services Aircraft Program in 1981 through the engineering, manufacturing and development phase in 1994. The focus of this thesis is to look at the relationship between the Joint Program Office, the parent companies of Bell Helicopter, Inc. and Boeing Helicopter, Inc., and the Government. The thesis also looks at other strategies that have been used in major weapon systems procurements such as the F/A-18 aircraft program which is being procured under a sole-source strategy. This thesis concludes that the acquisition of the V-22 has not been efficient and that Bell and Boeing Aircraft Companies, operating under a teaming concept, have not presented a single face to the Government.

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I. INTRODUCTION

A. BACKGROUND

> Effective application of *Operational Maneuver From the Sea* requires the capability to project forces deep inland from positions over the horizon. To realize this capability, which will vastly complicate an opponent's defensive problem and will substantially reduce friendly losses, we must replace the existing fleet of slow, aging medium lift helicopters, many of which are older than the pilots flying them.
>
> We expect to replace the CH-46 Medium Lift Alternative, which will serve as the backbone of the Marine Corps' assault support force well into the 21st century. This aircraft will provide a quantum improvement in mobility and tactical flexibility, complementing the revolutionary technology incorporated in the Advanced Amphibious Assault Vehicle and permitting unprecedented maneuver by amphibious forces. The MV-22 *is the Department's highest aviation priority of the Marine Corps.* (Department of the Navy 1994 Posture Statement, 1994, pp. 22-23)

The V-22 Osprey tilt rotor aircraft, as currently planned, is scheduled to replace the CH-46D/E and CH-53D helicopters that are currently being used by the Marine Corps. Additionally the U.S. Navy is planning the V-22 for Search and Rescue (SAR) and Combat SAR missions, while the U.S. Air Force is considering using the Osprey for special operations missions. The CH-46 and CH-53 aircraft entered service during the Vietnam War years of the 1960s. Since their introduction, numerous modifications and airframes changes have occurred that have extended these aircrafts' service lives and increased their mission capabilities. However, as they are now approaching the end of their useful service lives, it is time to replace the CH-46E and CH-53D that are currently in service with the Marine Corps. Several aircraft have been considered for their replacement and the V-22 Osprey developed by a team of Bell Helicopter, Incorporated and Boeing Helicopter, Incorporated was selected. To manage this team a joint program office was established that would represent the two companies to the Government. As the program progressed, it became apparent that the joint program office did not have the full autonomy that was required to properly represent each company. According to the Government's Procuring Contracting Officer (PCO), this has been a frustrating experience for the Government where often times the Government Program Manager or Government's Contracting Officer have had to deal

directly with the parent companies vice the joint program office (Interview with Roger Henry, 1994). This thesis will attempt to identify weaknesses in the teaming concept and propose a possible solution in order to encourage companies to engage in teaming so that the Armed Forces of the United States receive the best possible equipment at fair and reasonable prices.

B. PURPOSE

The V-22 program is currently in an Engineering and Manufacturing Development (EMD) contract. This EMD contract originally was a letter contract with definitization occurring in October 1992. The original acquisition strategy called for at least two contractors to compete with the final selection on a competitive wind tunnel "fly-off." Only one proposal was received and that was from the Bell-Boeing team. This teaming agreement was originally signed in May of 1982 and specified an equal division of effort which included all V-22 contracts with the Government within five years after first production delivery. This division of effort also included any other Government tilt rotor developments prior to the V-22. It was agreed that there would be cross-participation in all tasks and that all data used for the V-22 would be made available to either partner for any purpose.

In the area of management, a Bell-Boeing executive summary of the Joint Program Office stated:

> ORGANIZATION AND MANAGEMENT – A steering committee composed of the presidents of Bell and Boeing will provide advice and guidance and resolve problems which may arise. Bell and Boeing shall establish a Joint Program Office (JPO) to be staffed equally by Bell and Boeing. The Program Director and Technical Director will be appointed by Bell and the Deputy Program Director and Deputy Technical Director by Boeing....

It went on to say:

> The Bell-Boeing Joint Program Office (JPO) is the single point of contact for the Government and provides overall program direction to Bell and Boeing, including Program Policies and Procedures. The JPO, with Bell and Boeing support, has negotiated the FSD contract and established the work split between Bell and Boeing. (Smith 1989, pp. 11-12)

For the six full-scale development aircraft, called for in the Full-Scale Development (FSD) contract, Bell would be responsible for the wing, nacelle,

propulsion, and the dynamics. Boeing would assume responsibility for the development of the fuselage, empennage, avionics, and flight controls. (Smith, 1989, pp. 11-12)

This program arrangement has generated specific questions which this thesis will seek to answer.

The primary research question is:

- What lessons should be learned from the relationships established between the V-22 Joint Program Office, the parent companies of Bell and Boeing, and the Government?

The subsidiary research questions are:

- What is the contractual relationship between the Bell and Boeing Helicopter companies and how have they shared costs, risks, and profit?
- What are the principal difficulties associated with this teaming arrangement and what are the incentives to each company to overcome these difficulties?
- Can teaming facilitate performance in the best interests of the Government and the respective contractors?
- In a teaming arrangement can the respective companies acting through a joint program office present a "single face" to the Government?

C. BENEFITS OF STUDY

Current funding, along with the continuing decline of the Defense Department Budget and possible reorganization of roles and missions of the Armed Services, make it imperative that current and future weapon systems be procured with total costs of ownership in mind. Instabilities throughout the world will continue, consequently the operational tempo of U.S. Naval Forces will continue to be high. If the Department of Defense (DoD) is going to continue to place a high priority on leading edge technology weapons then the cost of acquisition will continue to be high. If the V-22 is to meet the Marine Corps' medium lift requirements well into the next century, then it is imperative that acquisition strategies such as teaming be explored now and those problems identified by this research be efficiently resolved. Through this research, the Navy/Marine Corps team will have better availability of information for new weapon systems procurement.

D. SCOPE OF THESIS RESEARCH

This will be a case study of the V-22 procurement and how the teaming arrangement has been used by Bell and Boeing. It will also cite other arrangements

currently in existence in DoD/Industrial contracts. Specific areas that will be addressed include the relationship and understanding between the parent companies, the exchange of technology, and the protection of technical data rights and trade secrets.

This study will not attempt to justify the need for the aircraft. This thesis is instead a compilation, through extensive interviews and research, of opinions and historical facts from which the findings and conclusions have been inferred. No classified information is contained in this thesis. A basic knowledge of major weapon system acquisition is assumed.

E. RESEARCH METHODOLOGY

The collection of research data has been comprised of a literature search to gather and analyze data from organizations such as Naval Air Systems Command (NAVAIRSYSCOM), Boeing Helicopter, Bell Helicopter, V-22 Joint Program Office, previous thesis work, and the Defense Logistics Studies Information Exchange (DLSIE). Additionally, interviews were conducted with members of the V-22 Program Office, V-22 Procuring Contracting Officer, NAVAIRSYSCOM, and the parent companies.

F. ORGANIZATION OF THE STUDY

This thesis is comprised of five chapters. Chapter II will introduce dual-sourcing as used in the DoD, its strengths and weaknesses and its use as a strategy to ensure competition. Chapter III will explain the history of the V-22 and why it was chosen as an evolutionary step between rotary and fixed-wing aircraft. Additionally, the Chapter will examine how Bell and Boeing became a team to produce the aircraft and their individual agendas for the Joint Program Office. Chapter IV will be an analysis of the Bell-Boeing teaming arrangement as well as other strategies that have been used in major weapon systems procurement. Chapter V will consist of conclusions and recommendations.

II. DUAL-SOURCING OF MAJOR WEAPON SYSTEMS

A. INTRODUCTION

Chapter I presented the Marine Corps' vision of replacing the CH-46D/E and CH-53D with the V-22 Osprey for the 21st century. The purpose of this thesis, along with its benefits, was discussed. The scope of research, methodology used and organization of the study were also explained. Chapter II will discuss the strategy of dual-sourcing, which was the original intent of the V-22 program. Various methods of dual-sourcing will be discussed; the V-22 and MK-48 ADCAP Torpedo will be introduced which highlight two dual-sourcing methods. Cost and pricing data, along with costs and competition in general, will also be discussed as they influence decisions in a dual-source environment.

B. BACKGROUND

The Government's initital strategy for the procurement of the V-22 was to form a team of aircraft manufacturers. Once the members of the team were qualified to produce the aircraft, the team was to be split and a dual-source would be available for the procurement. It was thought that this strategy of establishing a dual-source early in the production of the aircraft would create efficiencies through competition which would result in lower prices to the Government. (Interview with Major Pat Good, 1994)

The Department of Defense uses dual-sourcing in the acquisition process to obtain competition in the buying of weapon systems. In the past, dual-sourcing was used to obtain a second source for a particular weapon system after the system was in production. The passage of the Competition in Contracting Act (CICA) in 1984 provided the means to obtain cost savings through dual-sourcing. Dual-sourcing brings competition into an acquisition which results in lower prices to the Government. Also provided by CICA was the maintenance of a mobilization base and research and development capability within the industrial base of the United States. (Hampton, 1984, p. 7)

A review of the evolution of the systems acquisitions process reveals that as systems became more technically complex and expensive, the selection of a system contractor was made on technical considerations early in the acquisition process. Program managers selected the winning contractor as early in the process as possible to

minimize the costs of keeping two contractors involved through full-scale development. (Hampton, 1984, p. 7)

> During the 1960s, procurements generated large cost overruns and led to a general concern by Congress regarding the acquisition process. This concern resulted in several acquisition system changes. Time schedules were compressed through the use of concurrency. Design overlapped development and development overlapped production. Crash programs were instituted and special offices were created with authority to command the needed resources for system development and to communicate quickly through streamlined channels with higher echelons. (Hampton, 1984, p. 8)

The defense industry has, over the years, existed in a roller coaster environment of highly lucrative multi-billion dollar contracts when defense spending was high, contrasted with unexpected personnel layoffs and loss of capital during periods of constrained budgets, when hardware projects were suddenly dropped or drastically reduced in scope. (Hampton, 1984, p. 16) Through it all, contractors and the corporations who have tailored their services and products toward the defense market, have vied for the contract that would almost certainly bring substantial profits and stability to their companies, at least in the near term. Once a mission need is established, the design stage of acquisition has been a comfortable position for contractor competition in which the Government can then select the best product for the best price. It is during the production phase where the majority of total program costs are incurred and the cost of maintaining dual-sources may force the Government into a sole-source situation. The prime contractor has his foot in the door when cost over-runs and price increases begin. Due to the complexities and proprietary nature of many of our modern combat systems, there is really not much that can be done other than to work with the contractor and pay the higher price. In an attempt to spur competition during the production phase of weapons acquisition, efforts have been made to establish dual-sources for all new acquisitions, and also for many on-going defense weapon system programs. (Hampton, 1984, p. 18)

Dual-sourcing during production occurs when two or more firms are qualified and capable of furnishing Government requirements with contract award proportions determined by price. Each firm/contractor is assured an award for a portion of the annual buy. This should ensure that sufficient capability exists to continue production of the product through two competitive sources. The main reason for utilizing a dual-

source strategy is to obtain reductions in procurement costs by having two sources compete on a price basis for the largest quantity of production.

Acquisition personnel are concerned with the prudent expenditure of public funds. For example, a decision to dual-source a weapon system during production results in additional costs and potential benefits to the Government. If the decision is made on the basis of cost reductions, these costs and benefits must be quantified. However, there are other advantages to dual-sourcing such as expanding the industrial base, enhancing surge capability in time of war, and providing more than one source for product innovation which may prove difficult, if not impossible, to quantify accurately. Along with these advantages there are disadvantages to be considered including time and cost to educate a second source, higher program administrative costs, and variations of quality between sources.

To be able to implement dual awards for military procurement, a second source of supply must exist or be created. The costs of creating a second source of supply to begin production when not already established or producing can be very high. The investments, tooling, and other start-up costs needed by the second contractor which have already been incurred by the prime will be incurred by the second source, therefore the Government as well.

Dual awards require that both contractors bidding on an annual buy are guaranteed a portion of that quantity. The portion of the award that is guaranteed represents the minimum level of production the contractor requires to stay in production. The efficiencies and advantages gained in using competition are weakened. Due to the splitting of the production quantity between the contractors, neither may be able to fully realize the economies of scale. This well-known economic theory states that as the scale of production becomes larger, the efficiency of production increases and items can be produced at a lower cost. This is caused by the increase in specialization of jobs and improved use of resources, machines, and people. (Dolan and Lindsey, 1988, p. 583)

There are two general means of developing competition in production. First, where a second source is developed for an established sole-source program. Next, where production competition plans have been decided and are inherent in the acquisition strategy for fielding a new system. Both cases will involve significant additional up-front costs to the Government along with involved and potentially critical contractual negotiations. The earlier a firm decision is made for dual-sourcing, the

higher the probability of success for execution of the strategy from a contractual and cost perspective. (Boger and Liao, 1988, p. 15)

C. METHODS

The method of dual-sourcing used follows one of the following five techniques: form-fit-function, technical data package, directed licensing, leader-follower, and contractor teaming.

1. Form-Fit-Function

This method provides the second source with functional specifications such as size, weight, and performance parameters.

> This concept is typically thought of as the black box case and is normally employed where expendable, nonrepairable items within a component system, rather than large complex equipment in order to preclude logistical difficulties in technical repair and parts support in the field. (Spangler, 1990, p. 9)

The main advantage for this method of dual-sourcing is that it is an easy means to solicit competition. The contractor can employ any method that meets the Government's requirements and Government monitoring of contractors is minimized. This should allow for reduced overall costs per unit since the contractor is using his own existing manufacturing process. Minor disadvantages include source selection criteria that have to be carefully selected in order for the contractor to be aware of the implications of the critical performance elements and the ability to produce, and developmental efforts required by every procurement lead to higher program acquisition costs.

2. Technical Data Package

This is a stand alone package that contains sufficient manufacturing data to enable a second source, who may not have been involved in the initial development or production of a system, to produce the required item. No engineering or manufacturing liaison between sources is specified. Before the Government can use this technique it must acquire the technical data package either from the systems developer or through reverse engineering and have unlimited rights to the technical data. According to SECNAVINST 4210.9 of 25 January 1988:

> A level III package consists of the complete set of engineering drawings and instructions which fully describe characteristics of each component part, subassembly and end item, as well as detailed physical and performance characteristics, quality assurance provisions, materials

to be used, and manufacturing processes to be followed. (Spangler, 1990, p. 18)

The primary advantage of using this technique is once the Government has validated the technical data package it can be used again and again to maintain competition. However, the process of validating the technical data package can be costly and time consuming and once it has been validated the Government assumes responsibility for its accuracy. Once the Government assumes this responsibility, it is then liable for its accuracy if another source manufactures to the specifications contained in the technical data package. Also, the second source may not be able to manufacture from the technical data package because of differences in manufacturing techniques of the two contractors.

3. Leader-Follower

Under the leader-follower technique, the system developer or sole-source contractor serves in a leader role to provide manufacturing assistance and know-how to facilitate a follower company to become a capable source for a component or complete system. A direct contractor-to-contractor technical data transfer occurs. This method is generally used when a second source would be unable to produce without the leader's assistance. This assistance could involve materials support, training or technical assistance. The primary advantage of this method includes the minimization of the burden of technology transfer and enhanced use of the leader's capabilities. Disadvantages include the cost of giving the leader incentive to participate, the additional burden upon the Government to oversee this process, and possible relational difficulties that may exist between the potential leader and follower companies.

4. Direct Licensing

This method requires that when a company develops a second source, it is compensated by royalties or fees for technology transfer and licensing. The system developer retains rights to the proprietary data and maintains system responsibility. Advantages include minimization of the Government burden associated with technology transfer, the introduction of competition early in the process, and the utilization of the developing contractor's unique capabilities. Disadvantages include the cost of motivating the developer to enter into licensing agreements, possible reluctance or unwillingness of the initial contractor to cooperate with the second source, and high royalties or licensing fees may overshadow any gains made by the increased competition.

5. Contractor Teaming

Individual contractors combine to form teams who, in turn, compete in the design selection phase with other similarly formed teams. Each team member designs and fabricates specific subsystems and components of the system, with each ultimately sharing design and manufacturing data with each other. The team members must be competent and capable of producing the joint design on their own. The contractors enter into a teaming agreement with subsequent award of the contract to that team. For dual-sourcing to be accomplished through teaming, at some point during production the team will split with each member becoming a manufacturer of the entire system in their own right. The respective teams will each be producing the entire system and be in direct competition with each other. This may also be accomplished through the award of the prime contract to one of the team members with a requirement to subcontract with the other team members. Teaming has the advantage of combining innovation and design assets of the teamed organizations, maintaining and increasing the industrial base, and avoiding the difficulties associated with licensing and royalty fees. Disadvantages include possible violation of anti-trust laws, and increased contract evaluation costs because many contractors are involved.

D. COMPARISON OF TECHNIQUES

Examples of two dual-sourcing techniques being utilized for the procurement of two completely independent weapon systems will now be discussed. The V-22 is being procured through the contractor teaming method and the MK-48 Advanced Capability (ADCAP) Torpedo under the leader-follower technique.

1. V-22

The contracting teams for the V-22, as previously mentioned, are the Boeing and Bell Helicopter companies. While these companies' expertise lie in the development of fixed wing and rotary wing aircraft respectively, this was a logical team arrangement to design an aircraft that has the unique capabilities and performance characteristics of both fixed and rotary wing aircraft.

The V-22 Osprey had been planned for head-to-head competition between the two companies beginning with the second production year's award (U.S. GAO Report to Congress, 1986, P. 2). The first year's production of aircraft was to be split so that the Bell-Boeing team would jointly produce the first eight aircraft which would validate the design and manufacturing processes. Then the individual team members would each independently produce two of the remaining four aircraft in order to qualify as

production sources. A more detailed discussion of the Bell-Boeing team follows in Chapter III.

2. Teaming Problems

A problem that may arise here is that issues or problems that occur must be resolved first at the team level and then are referred to each respective corporation for review. This may entail reconciliation between the two corporate headquarters. Also the respective team members may not want to split the team and go into direct competition with each other when the project ends. Generally, the problem is that the team prefers the existing relationship over the approaching competition in which they may attempt to exercise the power of a sole-source.

Another problem with managing a program with a teaming concept is the more complex and demanding effort. Problems will arise such as dealing with two or more sets of management structures, and the physical distance of the team members' corporate offices in relation to the Joint Program Office. Also it must be noted that two different Defense Contract Management Command (DCMC) offices in different regions must be dealt with. Additionally, "a problem that occurs during a teaming project is that executives in the joint venture are sometimes still holding positions in their parent corporations as well as the joint team." (Corcoran, 1991, p. 103)

3. MK-48 ADCAP

The MK-48 ADCAP was the follow-on heavy torpedo for the Navy's MK-48. Then Secretary of the Navy, John Lehman, made the decision to dual-source the MK-48 ADCAP in late 1983 when the program was in the full-scale engineering phase.

> Because of the high technical complexity, the leader-follower technique was selected to ensure obtaining effective competition. This technique allowed for dual-source procurement immediately rather than using one of the other methods which would have delayed procurement. (Coyne, 1991, p. 48)

During the time of military build-up in the early 1980s, a major concern of weapons procurement was cost growth of individual weapon systems. It was decided to dual-source the MK-48 ADCAP in order to avoid unnecessary program cost growth.

The lead contractor chosen was Hughes Corporation. The primary reason for selecting Hughes as leader was that they were an experienced missile guidance and control manufacturer, with a robust reputation for engineering prowess in digital technology. With Hughes' help the Navy began a search to find a suitable follower for

the torpedo production. In April of 1986, Gould Corporation was selected by the Deputy Commander, Naval Sea Systems Command, Weapons and Combat System as the follower to Hughes Corporation. Gould had previously been sole-source for the MK-48 but had not developed the capabilities to manufacture and engineer the recently developed digital electronics. The original competitive MK-48 ADCAP demonstration and validation Request For Proposal (RFP) was issued in November 1978. This RFP addressed the requirements contained in the original operational requirements to meet an emergent Soviet threat. The RFP required the contractor to provide 20 prototype guidance and control sections along with supporting equipment. A total of five proposals were received in response to the RFP including one from the team of Hughes Aircraft Company and Gould, Inc. Hughes, a neophyte in torpedo production and development, was to perform the guidance and control development and overall systems integration. Gould was to build the afterbody, tailcone, fuel and propulsion systems. (Coyne, 1991, p. 28)

The primary reason for selecting Gould as follower to Hughes was their previous experience with MK-48 production which would be transferable to the ADCAP version (Coyne, 1991, p. 12). A key point in the relationship between Hughes and Gould was that Gould had previous experience in MK-48 production and Hughes had to rely on Gould to be able to qualify to manufacture a portion of the torpedo. This promoted a working relationship based on cooperation and mutual benefit. Since Hughes had no prior experience manufacturing torpedoes, this strengthened the relationship between the two companies.

4. Leader-Follower Problems

Some of the problems previously mentioned with teaming may also occur with the leader-follower technique. For example, the Government must deal with both the leader and the follower's management structures, often located in different geographic regions. Also, two different DCMC offices are involved with a leader-follower arrangement. Additionally, problems may arise if one or both companies involved attempt to acquire the necessary expertise that they lack from the other company. This would have the effect of giving one company an unfair advantage over the other in the future.

E. COST AND PRICING DATA

As previously mentioned, dual-sourcing is a procurement technique in which the total requirement is split between two contractors. This allows the Government and the

contractor to exploit the market situation to their own advantage. The larger share of the requirement goes to the low bidder and the smaller share to the high bidder. It must be determined that adequate price competition exists. It cannot be assumed that dual-source prices are fair and reasonable without some analysis into the basis of a contractor's prices. (Boger and Liao, 1988, p. 16) It is at this point that the contracting officer may need cost and pricing data to determine whether appropriate price competition exists. Just because a requirement is being dual-sourced does not necessarily mean that true competition exists. It is normally presumed however, that adequate price competition will exist on dual-source procurements. In order to ensure that contractors propose the lowest price possible, the Federal Acquisition Regulation (FAR) provides contracting officers the means to obtain adequate cost and pricing information. When a contracting officer does obtain cost and pricing data, this provides a sound basis of the contractor's proposed prices and the contracting officer is therefore in a better position to negotiate any reductions to the contractor's proposal.

F. COSTS

In a dual-source environment, it is too important a consideration to assume that adequate price competition automatically exists. There is a need to obtain information on a contractor's proposed dual-source prices as a way of determining whether adequate price competition exists and fair and reasonable prices are being negotiated. It should be noted that when evaluating a contractor's prices, since the production quantity is being split, the Government will lose some savings. The smaller production rate between the two contractors will probably mean higher unit costs because neither contractor is able to fully realize the economies of scale (Dolan & Lindsey, 1988, p. 563). The basis for using dual-source competition is that the bid prices should be lower under a competitive environment as compared to a sole-source acquisition, thus resulting in a net savings to the Government. (Hampton, 1984, p. 22)

When reviewing a contractor's costs, the following points should be included in the analysis. Does the proposed price reflect accurate material estimates? Are labor and indirect expense rates higher than those recommended by organizations such as the Defense Contract Audit Agency? Is the profit rate higher on this contract than similar noncompetitive contracts previously awarded to this contractor? Do prices reflect material price reductions that the contractor should expect to achieve during production or during negotiations with vendors?

The prime/sub contractor relationship appears to lend itself to cost increases since the Government is dealing with two independent contractors. This means that the Government may be paying double for overhead, profit and other design expenses. However, when a joint teaming arrangement is used instead of a prime/sub relationship, contractors may be discouraged from applying overhead and profit on top of the other team members. (Hampton, 1984, p. 23)

G. COMPETITION

A discussion of competition enables one to understand how dual-sourcing can be used by the Government to further its goals of procuring goods and services at the lowest possible price to the taxpayers. It appears that the Department of Defense is depending more and more on the market place to provide adequate competition and this competition is thought to work better than procuring from a sole-source. The adoption of the Competition in Contracting Act of 1984 has had a great deal to do with the way the Department of Defense now manages its procurement functions. It is generally accepted that competition lowers procurement prices and indirectly improves product quality. Full and open competition is probably the best arrangement to employ and dual-sourcing is probably as close as one can get to full and open competition when procuring for large and complex weapon systems such as the V-22 and MK-48 ADCAP programs. (Panel Discussion Sponsored by the Military Reform Caucus, 1990, p. 25) Dual-sourcing may create adequate price competition which could be used to produce fair and reasonable prices for our weapon systems. On the other hand,

> ...the GAO, DoD and the IG have recently given reports that raise questions about whether dual-sourcing can be relied on to ensure that prices are fair and reasonable. They urge that other safeguards be employed along with dual-source contracts to ensure that prices are fair and reasonable. For example, they suggest that contracting officers obtain cost and pricing certifications from contractors. (Panel Discussion Sponsored by the Military Reform Caucus, 1990, p. 35)

A contracting officer may seek to obtain cost and pricing data, especially if a second source has never produced a particular product before or has had limited experience in producing the item. Early in a dual-source acquisition program, a contracting officer may want to obtain cost and pricing data 100% of the time because there are no learning curve data available. However, if the particular product that is being procured has been in production for several years, historical data should already be available and these data can be used to evaluate the second source.

Contracting officers must not assume that adequate price competition exists in dual-source contracts before they obtain some insight into the basis of the contractor's proposed policy. Price analysis alone used to establish the reasonableness of a price is not always an effective indicator of judging adequate price competition. Cost analysis must be also used. (Panel Discussion Sponsored by the Military Reform Caucus, 1990, p. 37) If the cost and pricing data supplied by the contractors are not certified to be current and accurate and are not adequately analyzed by the contracting officer and DCAA, then the Government is unprotected and has no recourse to recover money from any over-pricing that may occur. On the other hand, if a contracting officer is getting bids from dual-source competitors and he wants them to submit certified cost and pricing data, the time to request this information would be when the Request for Proposal goes out. The bidders would then come back with their proposals and the proposals would be audited and reviewed. This review would then be returned back to the contracting officer.

Since most contractors are dependent on suppliers for determining what their pricing is going to be and the Government is developing dual-sources and increasing competition, contractors reacting to this may lower their prices in this climate of competition. The contractors must be very accurate when determing prices and they should be even more accurate as competition increases. This will cause the contractor to make sure its suppliers and subcontractors have their prices in line and at the lowest cost. Thus, these lower prices resulting from dual-sourcing should ensure the Government is getting the lowest prices over the long-run.

When looking at costs, not all are easily defined and categorized. Direct labor and direct materials are always associated with production and are therefore classified as a recurring cost. If a contracting officer is attempting to qualify a second source a large amount of direct labor and direct materials may be used and these costs would then be classified as nonrecurring.

> Also what must be considered by the Government in addition to recurring and nonrecurring costs when deciding to proceed with dual-source competition are acquisition methods, pricing strategy, total requirements and the planned production rate. (Boger and Liao, 1988, p. 48)

In many dual-source cases, one of the two contractors has been providing the good or service longer than the other, therefore the competitive position of the two

contractors may be unequal. Then the competitive pressure from dual-sourcing may diminish or disappear completely. If the first supplier of a product has developed that product, then this supplier will enjoy a cost advantage over the second source. Generally, the more experienced producer will have lower production costs and can under-bid the new supplier.

The contracting officer can face a dilemma in establishing a second supply source. The combined production capacity may exceed the actual requirements if the second source is established at the same production capacity level as the original source. If the second source's production capacity is established at a lower level than the first source, the second source would not be in a position to bid at the higher percentages of the annual requirement, this would create an unfair advantage for the original source.

H. LOOKING TO THE FUTURE

Recent events have shown that America, and in particular the Department of Defense, will be facing periods of reduced budgets. This will most likely continue through this decade and into the next century. There are many factors contributing to this, mainly the collapse of the Soviet Union and the political will of Congress to reduce deficit spending of the Federal Government. Maintaining the industrial base of the country will be challenging in the years ahead. One possible means of maintaining adequate production capacity for Government procurements is dual-sourcing. As we look at the many factors affecting procurement of major weapon systems, one point clearly stands out and that is that these systems will become increasingly more expensive. As the associated research, design, development, and production costs rise it will become advantageous for contractors to team in order to share these risks.

In addition to the two systems mentioned previously, the V-22 and MK-48 ADCAP, there other systems and programs that will be developed through teaming arrangements, such as the Air Force's F-22 fighter and the Army's Commanche helicopter. There are also many goods and services required by the Government that are not as costly as weapon systems that can also be procured by dual-sourcing. With proper planning, the Government may look to dual-source goods and services if feasible. This could help to ensure that the Government receives an adequate return on their investment, and to help maintain the shrinking industrial base we are currently facing. However, if the Government, and in particular contracting officers, are not

diligent in their duties cost overruns will continue to be a major problem and adequate price competition will not occur, thus the benefits of dual-sourcing will not be realized.

As was previously mentioned, Bell-Boeing formed a team for the production of the V-22. At that time the Government's strategy was to ensure that two sources of supply were available to manufacture the aircraft. The Government was attempting to ensure competition through a dual-sourcing strategy. However, as will be shown in Chapter III, the Bell-Boeing team will not be split and the V-22 will be procured via sole-source.

I. SUMMARY

This Chapter looked at dual-sourcing and specifically how DoD uses dual-sourcing in the acquisition process. Considerations such as competition, costs, and cost and pricing data were addressed. Five dual-sourcing methods were introduced. In particular, the V-22 Osprey under the contractor teaming method and the MK-48 ADCAP under the leader-follower technique were discussed. Chapter III will present the history of the Osprey program and an evaluation of the acquisition strategy. The program's chronology will be presented with emphasis on Congressional efforts to continue the program while DoD, under the Bush administration, attempted to terminate the program. Also, Bell-Boeing's vision of tilt rotor technology will be given.

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III. HISTORY OF V-22 PROGRAM MANAGEMENT

A. INTRODUCTION

The previous Chapter introduced the reader to the concept of dual-sourcing a major weapon system, which was the V-22's original acquisition strategy. This original strategy called for the Bell-Boeing team to be split once the program was in production, which would have established the dual-sources. Chapter III will look at the origin of the V-22 program beginning with research aircraft of the 1950s through the establishment of the Joint Services Aircraft Program. A chronology of the V-22 program will be presented with emphasis on Congressional support and DoD's attempts, under the Bush administration, to cancel the program.

B. ORIGIN OF THE PROGRAM

The birth of the Joint Services Aircraft Program can be traced to an August 27, 1981, Under Secretary of Defense (Research and Engineering) memorandum to the Service Secretaries suggesting that the Army's electronic warfare mission, the Marine's assault mission, the Air Force's special operations mission, and the Navy's search and rescue mission requirements might best be met with a single, advanced but mature technology, such as an operational derivative of the XV-15 Tilt Rotor experimental aircraft. (U.S. GAO Report to Congress, 1986, p. 2)

Tilt rotor technology was first successfully demonstrated in the 1950's using Bell Helicopter's XV-3 research aircraft. Later, a joint NASA/Bell/Army effort resulted in the successful testing of the XV-15 research aircraft in the 1970s and 1980s.

A Deputy Secretary of Defense memorandum to the Service Secretaries on December 30, 1981, formally established the Joint Services Aircraft program. The Services regarded this memorandum as approval for concept formulation, waiving the need for a Justification for Major Systems New Start, the formal need statement. The Deputy Secretary endorsed the Army as the executive Service and a Marine Corps officer as the program manager. The Joint Services Aircraft program was to be executed according to Army standard development and acquisition procedures. The Office of the Secretary of Defense then directed the Army, Navy, and Air Force to each reprogram approximately $1.5 million to conduct a joint technical assessment of the technology available for the Joint Services Aircraft system. (U.S. GAO Report to Congress, 1986, p. 2)

Responding to the December 1981 Deputy Secretary of Defense initiative, in February 1982 the Services assembled a joint technical assessment group of experts to develop preliminary point designs and tradeoff options for the Joint Services Aircraft. The joint technology assessment group completed its assessment in May 1982 and concluded that the application of tilt rotor technology offered the best potential for a common multi-service aircraft. The group also concluded that other technology such as conventional helicopters, compound helicopters, the advancing blade concept and the lift/cruise fan concept were less attractive in terms of speed and worldwide self-deployability for combined Joint Services Aircraft applications than the tilt rotor aircraft. (U.S. GAO Report to Congress, 1986, p. 2)

In May 1982 two aircraft manufacturers, Bell Helicopter Textron and Boeing-Vertol, anticipating a request for proposals for the design and development of the Joint Services Aircraft, teamed together for the Joint Services Aircraft competition. Both these companies had prior experience with tilt rotor technology. The teaming agreement called for joint production of the Joint Services Aircraft through at least the fifth year from initial production delivery. (U.S. GAO Report to Congress, 1986, pp. 2-3)

In June 1982 the Army Chief of Staff formally announced the selection of the Joint Services Aircraft program manager. At that time the program manager held a Bachelor of Science degree in Electrical Engineering and a Master of Science degree in Management. The Joint Services Aircraft was the program manager's first assignment as a program manager. It is interesting to note that he had no previous program management or contracting experience. He became involved with the Joint Services Aircraft program in June 1981, as the manager of the Navy forerunner of the Joint Services Aircraft program.

A Memorandum of Understanding concerning the Joint Services Aircraft program was signed between the Army, Navy, and Air Force on June 4, 1982. This memorandum established the Joint Services Aircraft program objectives and the funding approach. The Services agreed to provide $167 million in fiscal year 1984: the Army's share was $78 million, the Navy's share was $70 million, and the Air Force's share was $19 million. Funding shared for the remainder of the Joint Services Aircraft program agreed to at this time were: Army, 46 percent; Navy, 42 percent; and Air Force, 12 percent. The memorandum designated the Army as the executive

Service, and it required achievement of the earliest practical initial operational capability. (U.S. GAO Report to Congress, 1986, p. 3)

The Deputy Secretary of Defense approved the Joint Services Aircraft acquisition strategy (Army-originated), number P42-37-0-30, on 8 December 1982, and Naval Air Systems Command officials signed the strategy in January 1983. The acquisition strategy states that "advanced, but mature technology based on existing demonstrator aircraft will be exploited." Risk reduction techniques mentioned in the strategy include:

- using design, wind tunnel, and flight test data already developed during the Army/NASA XV-15 Tilt Rotor Program;
- encouraging industrial teaming to exploit a broader technology base; and
- competing the preliminary design effort. (U.S. GAO Report to Congress, 1986, p. 3)

The strategy called for competitive development up to full-scale development. It also stated that:

> As the Joint Services Aircraft program does not require a discrete demonstration and validation phase, approval of the acquisition strategy by the Defense Acquisition Executive precludes the requirement for a formal review ... as required by Department of Defense Directive 5000.1. (U.S. GAO Report to Congress, 1986, p. 4)

The strategy also allowed for the Defense Acquisition Executive to make the Milestone II program review if the program was within cost and on schedule.

On December, 13, 1982, the Secretary of the Navy approved an addendum to the Memorandum of Understanding. This addendum designated the Navy as the executive Service for the Joint Services Aircraft program, replacing the Army. According to the program manager, the Navy became the executive Service because the Army had allowed the initial operational capability date to slip and the Marines had the most pressing initial operational capability date. (U.S. GAO Report to Congress, 1986, p. 4)

The program manager wrote the part of the strategy regarding schedules and delivery requirements and the Army contracting officer wrote the sections regarding business and contractual matters. The Navy contracting officer did not play a role in preparing the acquisition strategy until the program was transferred to the executive leadership of the Navy. At that time the contracting officer provided input into

contracting matters to have the strategy comply with Navy contracting philosophies. (U.S. GAO Report to Congress, 1986, pp. 3-4)

The joint Services operational requirement was approved on 14 December 1982. The requirements document called for an aircraft with a continuous cruise speed of not less than 250 knots and, to meet worldwide self-deployment objectives, a minimum range capability of 2100 nautical miles, unrefueled. Anticipated acquisition quantities were approximately 1100 for all three Services.

The requirements document favored a tilt rotor design. It stated that the conventional helicopter could not meet Joint Services Aircraft cruise speed and worldwide self-deployment requirements stipulated by all three Services. It also stated that the tilt rotor configuration could perform all of the Joint Services Aircraft missions, using a common, basic air vehicle with special mission configurations and equipment to meet specific Service requirements. (Tiltrotor - A Brief History, 1991, p. 18)

In a memorandum issued on 27 December 1982, the Under Secretary of Defense (Research and Engineering) directed the Navy to take the executive Service lead for the Joint Services Aircraft airframe, while the Army continued as the executive Service for the development of the modern technology engine to be used in the Joint Services Aircraft. The memorandum also reapportioned the funding shares previously established in the Memorandum of Understanding.

According to a Navy official, after the Navy took over as the executive Service of the Joint Services Aircraft program, the Naval Air Systems Command contracting officer, Assistant Commander for Contracts, and legal counsel changed the preliminary design request for proposals contracting strategy from a fixed-price level of effort to a cost-plus-fixed-fee arrangement. (Smith, 1989, p. 7)

The first Navy contracting officer for the Joint Services Aircraft program was appointed in December 1982. According to a program official, because of the short time frame between when the Navy was appointed and when it took over as the executive Service for the program, the contracting officer was appointed on a temporary basis until a permanent contracting officer could be appointed. She was the contracting officer for three other programs at that time and had been the contracting officer for the program that was the Navy forerunner of the Joint Services Aircraft program. The second contracting officer for the Joint Services Aircraft was appointed in February 1983. (O'Brien, 1992, p. 15)

The program manager released a draft request for proposals for preliminary design to industry for comments in late July 1982. About 269 comments were received and about half of these were incorporated into the second draft which was released in October 1982. The final request was released on 17 January 1983, in accordance with the December 1982 Secretary of Defense Decision Memorandum. The contracting officer developed and issued the request, with advice from the program manager. (U.S. GAO Report to Congress, 1986, pp. 6-7)

The Joint Services Aircraft program followed formal source selection procedures. On 5 January 1983, the acting Secretary of the Navy signed the document which designated the Commander, Naval Air Systems Command, as the source selection authority. The source selection authority then appointed the members and chair of the source selection advisory council. The program manager and the Assistant Commander for Contracts were both designated as advisers to the source selection advisory council. In addition, the source selection authority established an evaluation board of which the contracting officer was a member, and the program manager was an adviser.

The source selection plan was approved by the source selection authority on 10 January 1983. The program manager did not have an active role in the plan development, whereas the contracting officer provided contractual input into and reviewed the plan.

On 26 April 1983, the contract for preliminary design was awarded to the Bell-Boeing team. Their proposal was the only one received in response to the request for proposal. For the contract award, the program manager assured regulations were followed. The source selection evaluation board evaluated the proposals, the contracting officer conducted the negotiations and issued the contract. The contract for Joint Services Aircraft preliminary design was awarded on a cost-plus-incentive-fee basis, with incentives on cost only. (O'Brien, 1992, p. 18)

The Navy anticipated two contractors would compete during the preliminary design stage which would end with a competitive wind tunnel "fly-off" to select the winning contractor. This plan had to be modified because only one proposal was received, even though the preliminary design phase had been extended from 15 to 23 months before the request for proposals was released in hopes of further stimulating interest and competition for the contract.

According to program officials, Sikorsky Aircraft actively considered competing for the preliminary design, but at the last minute decided not to submit a proposal, leaving Bell-Boeing the only contender. According to Sikorsky officials, they did not submit a bid because the preliminary design stage did not allow them sufficient time to evaluate the technical risks of the program. Sikorsky believed they needed approximately 34 months instead of 23 months for preliminary design. However, according to the contracting officer, Sikorsky notified the Navy at the last minute that they would need more time for the preliminary design stage even though the preliminary design stage had already been extended from the original 15 months to 23 months. Until this time, the contracting officer expected Sikorsky to submit a proposal. (U.S. GAO Report to Congress, 1986, pp. 6-7)

Grumman Aerospace officials indicated that, although competition was bred into the early stages of the program, it was lessened in the later stages as a result of the requirements driving the design toward the tilt rotor concept. Grumman did not fault anyone for this, calling it a matter of Service priorities. (O'Brien, 1992, p. 20)

A statement by the then Commander of the Naval Air Systems Command also addressed the question of why only one proposal was received:

> As to why no other proposal was received, it can only be surmised. Even with the expansion of the initial effort to 23-months work, other industry management may have perceived that the Bell-Boeing's lead and prior experience with tilt rotors was insurmountable. Even though NASA's complete tilt rotor data package had been made available, they apparently felt that, without a further expansion of the effort, i.e., 33 months, the probability of winning was low. The Bell-Boeing team had put their company sources at risk and formed working teams while the program was still in the formative stages. No one else made a comparable commitment. (U.S. GAO Report to Congress, 1986.)

The program manager believes a fair competition for the Joint Services Aircraft's preliminary design was held.

- The request for proposals for preliminary design did not specifically preclude use of alternative concepts.
- Full access to data from the tilt rotor research aircraft, the XV-15, was provided.

- Pilots from competing firms were allowed to fly the XV-15 demonstrator aircraft.
- The draft request for proposals was sent to the contractors twice for their review and comment.

> Officials said that although the joint technology assessment concluded the tilt rotor was a mature technology with relatively low risk, other types of designs such as an improved version of a conventional helicopter conceivably could have challenged the tilt rotor concept. (U.S. GAO Report to the Ranking Minority Member, 1990, p. 3)

The program manager stated that any proposal submitted would have been independently and objectively evaluated on its own merits, regardless of the particular concept it proposed. Program officials believe, however, that the tilt rotor concept was the only "available and mature" concept that could satisfy the operational requirements of the Joint Services Aircraft program, particularly its speed and worldwide self-depolyability requirements. (U.S. GAO Report to Congress, 1986, pp. 7-8)

In May 1983 the Army withdrew from the Joint Services Aircraft development program but reentered the program following a September 1983 Defense Resources Board meeting. The Defense Resources Board approved continuation of the joint program, with full funding for Joint Services Aircraft common development within the Navy's total obligation authority. It deleted the Air Force combat search and rescue mission and substituted an assault need for the Army's special electronics mission aircraft need. The Army plans to use the Marine assault version of the Joint Services Aircraft for its medium cargo lift and medical evacuation needs, while the Air Force plans to use the Joint Services Aircraft for its special operations forces needs. (O'Brien, 1992, p. 33)

The House and Senate conferees agreed to provide the Joint Services Aircraft program with $88.6 million for fiscal year 1984. All funding was consolidated under Navy Research, Development, Test and Evaluation. The funding consolidation was intended to strengthen the program by assigning control of the funds directly to the Service with executive leadership. The Congress appropriated $188.5 million for fiscal year 1985 and $580 million for fiscal year 1986. (U.S. GAO Report to Congress, 1986, p. 9)

The Commander, Naval Air Systems Command approved the Joint Services Aircraft revised acquisition strategy (No. A-42-37-0-40) in June 1984 and the Chief of

Naval Materiel approved the strategy in August 1984. The revised strategy reflected plans to have Bell-Boeing develop the aircraft as a joint effort. In November 1984 the Commander, Naval Air Systems Command and the Commander, Aeronautical Systems Division, signed the program manager's charter for the Joint Services Aircraft and the Secretary of the Navy selected "OSPREY" as the Joint Services Aircraft's popular name. In January 1985 the Joint Services Aircraft was designated the V-22.

In acquisition strategy A-42-37-0-30 (dated 8 December 1982), the Navy estimated the average unit cost for the 913 aircraft in the program to be $14.6 million, in fiscal year 1983 dollars. An official in the Joint Services Aircraft program office indicated that the Joint Services Aircraft unit cost was $15.6 million in fiscal year 1984 dollars for the 913 aircraft. (U.S. GAO Report to Congress, 1986, p. 10)

To ensure that both companies were qualified to compete with each other after the pilot production lot, they were required to submit — as a full-scale development contract deliverable — a production plan that included a technology transfer plan and certification that each of their production processes were equivalent for aircraft delivered under the pilot production lot. This contracting strategy is still subject to negotiation between the Navy and the contractor. (U.S. GAO Report to Congress, 1986, p. 12)

C. EVALUATION OF ACQUISITION STRATEGY

The program manager developed a Joint Services Aircraft contracting strategy driven by operational requirements that, according to some officials, could realistically be met only by the proven tilt rotor technology. As a result, the only response to the request for proposals was from the team with prior experience with this technology. Although the acquisition strategy called for competitive development up to full-scale development, the teaming of the technology leaders resulted in early curtailment of the competition. Navy top management initially accepted the contracting strategy proposed by the program manager and contracting officer. However, top Navy management expressed a desire to change the terms of the production schedule to one in which the Bell-Boeing team will compete with production lot one. (The teaming agreement calls for joint production through at least the fifth year from initial production delivery). The program manager said that both Bell and Boeing are supporting the Navy's strategy to split the team. Boeing stated in a letter that the team recognizes the Navy's right to split the team at its direction.

D. PROGRAM CHRONOLOGY

During 1986 the program was also restructured to provide for a fixed-price incentive contract. On 2 May 1986, Bell-Boeing was awarded a full-scale development contract for the Joint Services Aircraft airframe with a target price of $1.714 billion. A firm fixed-price contract was also awarded to Allison Gas Turbine Division of General Motors for $76.4 million for engine development.

Congress funded the program for fiscal years 1986 through 1991 to the total of $2.7 billion of which $2.2 billion has been for research, development test, and evaluation. The first flight of the V-22 Osprey took place on Sunday, 19 March 1989. (U.S. GAO Report to the Ranking Minority Member, 1990, p. 8)

1. Program Cancellation

Problems continued to grow for the V-22 program in 1988. The Army officially dropped out of the program in February, resulting in significant per aircraft cost growth. Additionally, program delays and weight growth threatened the entire program. (V-22 Price Starting to Climb, 1988, pp. 1-3.) The flight test program slipped from mid-1988 to March of 1989, with the first flight of the V-22 on 19 March. Congress became actively involved for the first time in 1988 in urging DoD to investigate the civil applications of tilt rotor technology as a means of lowering overall program costs and "to give it some resistance to current uncertainty in funding." (Congress Urges DoD, FAA, NASA, 1986, pp. 6-7)

In June of 1988 the Office of the Secretary of Defense (Program Analysis and Evaluation) (PA&E) headed by Dr. Chu released its report recommending the termination of the V-22 program in favor of a more cost-effective all helicopter option. The report remains highly controversial as it was developed "in-house" by PA&E without input from either the Navy or the Marine Corps. (OSD PA&E Recommend Termination of V-22, 1988, pp. 1-4)

The remainder of 1988 was spent investigating various contracting options and funding plans to keep the V-22 a viable program. By the end of 1988 there were definite signs that the V-22 was in trouble. In November OSD cut the Navy's FY-90 budget request from $1.2 billion to $900 million, funding 21 rather than the requested 36 production V-22s. (Navy '90-'91 Budget cut V-22 Buys, 1988, pp. 3-4) The Marine Corps, however, still considered the V-22 its "highest priority aviation program." (Washington Roundup, 1988, p. 17) In March of 1989 the Secretary of the Navy, William Ball, recommended a $1 billion cut in funding and a one-year delay in

start of production. The Marine Corps opposed both the funding cut and the production delay. (Navy Chief Recommends $1 Billion Cut, 1989, p. 7)

In April of 1989, Secretary of Defense Cheney announced the cancellation of the V-22 based primarily on the recommendation of Dr. Chu. As Dr. Chu stated in his earlier PA&E report, "the V-22 was a cost prohibitive option compared to an all helicopter buy of UH-60s and CH-53Es." (Pentagon Wants V-22 Canceled, 1989, p. 18) An amended FY-90 budget was submitted to Congress in May of 1989, deleting all funding requests for the V-22 and, instead, requested funding for a new medium lift replacement alternative study (presumably Chu's all-helicopter option). (Naval Aviation: The V-22 Osprey, p. 27)

Congressional response to Cheney's cancellation move was slow to materialize. By June the House Armed Services Sub-Committee on R&D had voted to shift $351.8 million from the B-2 and SDI programs to the canceled V-22 program for FY-90. (House Votes V-22 Osprey Money, 1989, p. 1354) Congressional support for the V-22, while always strong, increased markedly from June through the end of the year.

Representative Weldon and Senator Specter of Pennsylvania became the primary leaders of a growing coalition of congressmen who strongly supported continued V-22 development. By the end of 1989 this coalition included over 125 members of the House and 20 Senators. By November, both the House and the Senate had included full R&D funding in their FY-90 budgets despite OSD's request for the program's cancellation. Production funding, however, remained tentative. (O'Brien, 1992, p. 21)

Congress provided $255 million in RDT&E funding for FY-90, as Rep. Foglietta (PA) said, to "allow the Osprey program to fly for another year and to sell itself to the Defense Department." (Foglietta Predicts V-22 Will Be Reinstated, 1989, p. 5) As part of the FY-90 authorization and appropriations bill, Congress also directed OSD to complete a Cost and Operational Effectiveness Analysis (COEA) study of the V-22 program. The Institute for Defense Analysis was tasked with analysis of the V-22, focusing on amphibious assault in a hostile environment, long-range special operations, over-the-horizon landings, subsequent operations ashore, logistical resupply to forward deployed forces and self-deployment missions. (O'Brien, 1992, p. 22)

In December 1989, Secretary Cheney ordered the cancellation of $344 million in FY-89 advance procurement contracts for the V-22 ($260 million of which had not been spent). This decision set off a storm of criticism from Congressional supporters.

The decision to terminate existing FY-89 contracts was termed by Rep. Weldon as a "blatant disregard of the defense authorization process and for congressional will." By canceling the V-22 procurement Weldon said, "Secretary Cheney displayed the ultimate in arrogance by trying to administratively subvert the defense budget process while Congress was in recess." (V-22 Termination Touches Off Congressional Storm, 1898, p. 24) Weldon further stated that "the cancellation decision while Congress was in recess would further galvanize congressional support and damage the Pentagon's reputation on the Hill." (Congress-DoD Relations Hurt by V-22, 1989, p. 40)

2. 1990 Congressional Action

In January 1990, still reeling from the decision to cancel FY-89 procurement contracts, Congressional supporters tried to determine the legality of Secretary Cheney's cancellation order. Despite their anger with OSD, however, most supporters agreed to abide by the Institute for Defense Analysis (IDA) COEA recommendations which were due to be released in April. In the interim, Rep. Weldon continued to solicit support for the program and to lobby fellow congressmen. Calling the Pentagon "penny wise and pound foolish" he asked for a re-examination of the PA&E report, arguing that life cycle cost analyses would show the V-22 less expensive. (Weldon Predicts $500 Million for V-22, 1990, p. 193)

The PA&E report based much of its conclusions on the technique of dual slinging heavy vehicles on CH-53E helicopters, thus decreasing transport times and/or reducing the number of required helicopters. In testimony before the House Armed Services Committee on February 20th, 1990, General Gray, Commandant of the Marine Corps, said, "I consider this whole dialogue of dual sling options totally ridiculous, it has nothing to do with coming from the sea in a wide variety of scenarios... it has nothing to do with warfighting. It is totally ridiculous and tactically flawed." (Gray: V-22 Substitute Scheme Ridiculous, 1990, p. 6) General Gray went on to say that a 1989 DoD study found that the helicopter option would cost $6 billion more that the V-22 option.

In April, a study commissioned by Bell-Boeing and conducted by the BDM corporation found the V-22/CH-53E mix vastly superior in combat effectiveness to the all helicopter option but $7 billion more expensive. This was based on a fleet of 602 V-22s. (BDM Study, 1990, p. 93-94) The IDA report was also completed in April as mandated by Congress. However, OSD did not release its findings to Congress until mid-May. Because the report's V-22 findings were in favor of the V-22, supporters in

Congress accused Secretary Cheney of trying to willfully suppress its results. (Institute for Defense Analysis Study the V-22 Osprey, 1990, p. 42)

3. 1991 – 1994 Congressional Action

As previously stated, Congress authorized and appropriated $255 million for R&D on the V-22 pursuant to an agreement reached with the administration that the program would terminate with R&D and not proceed to production at that time. (The Status of the V-22 Tiltrotor Aircraft Program, 1992, p. 3) The agreement was that DoD would continue development of the aircraft. In fiscal year 1991 DoD was authorized $238 million for RDT&E, $165 million for long lead item procurement and $200 million in prior year funds for V-22 R&D, and specifically prohibited from using those funds to try to find an alternative, affordable means of meeting the Marine Corps medium-lift needs. (O'Brien, 1992, p. 26)

Congress passed its Defense Appropriations and Authorization bill in late November 1991 and it is generally hailed as a victory for the V-22. It provided $790 million, including $165 million of prior year procurement funds, to embark on Phase II full-scale engineering and manufacturing development. Three pilot production aircraft were authorized to incorporate engineering changes identified during flight testing. Additionally, it directed the Navy to provide a Test and Evaluation Master Plan (TEMP) by 1 May 1992 and report results of current testing to Congress by 15 April 1992. Finally, the bill prohibited the Navy from investigating V-22 alternatives until the results of Phase II were available. (O'Brien, 1992, p. 28)

It is interesting to note that the total planned aircraft procurement had shrunk from over 1000 to 657 at the time the production portion of the contract was canceled. It is now generally accepted that yet a much smaller buy will occur if the program ever does proceed to the production stage.

By August of 1992, DoD had not spent the $790 million because they believed the V-22 could not be built to meet the requirements specified in the fiscal year 1992 Appropriations Act. The DoD General Council made a determination on that point, the point being that it was an engineering impossibility to comply specifically with the statute. Therefore, the DoD was enjoined against signing any contract which they knew could not be fulfilled based on the General Council's determination. The Secretary of Defense then proposed a compromise plan which would require implementing legislation to repeal fiscal year 1992 direction, thereby, allowing DoD to

use the fiscal year 1992 funds for the continued development of the V-22 aircraft while further exploring Medium Lift Requirements (MLR) alternatives.

As funds were appropriated, the administration appeared to continually find various faults with the V-22 or with the language contained in various Appropriations Acts which would prevent the program from continuing. During Hearings before the Procurement and Military Nuclear Systems Subcommittee of the House Armed Services Committee, Mr. Chet Edwards, representative from Texas, said,

> You know that when DoD supports a program, the lawyers are put in the back offices to rationalize the problems, and when DoD doesn't want a program it brings in the lawyers and decides on some way to kill it. Frankly, I think the discussion of moving the goal posts – in this case I don't think the goal posts have been moved, I think the football players are on the field and DoD decided we are going to play soccer. When you are opposed to a program, DoD is going to kill it. I would like to see the double standard stop. If we are going to play by these rules, play by the rules on everything including the A/X, SDI, B-2, and the C-17. I hope that would go beyond the legal answer you just gave a minute ago and apply to all major operational requirements. (The Status of the V-22 Tiltrotor Aircraft Program, 1992, p. 21)

Mr. Edwards, representing Texas, the home state of Bell Helicopter, was responding to an answer given by Sean O'Keefe who was then the DoD's comptroller and chief financial officer. During this testimony it appeared that DoD was looking for ways to cancel the V-22 program or find an alternative to the Marine Corps' medium lift requirement.

For fiscal year 1993, the House approved $755 million for the FY-93 Defense Authorization Bill. These funds were to be used to fund the remainder of the six aircraft program. On 25 July 1994, the Senate Appropriations Subcommittee on Defense approved $497 million in fiscal year 1995 funding for continuation of V-22 Engineering and Manufacturing Development. The Senate Armed Services Committee was the last of the four key congressional committees to authorize funding for V-22 at DoD's requested level. Next on the docket will be full Senate committee decision on appropriation of the V-22 funding. Commenting on the Senate action, Sen. Arlen Specter (R-PA) noted that,

> After years of debate on the value of the V-22 program, which I have always viewed as vital to our national security and an important

piece of technology, it appears that a consensus has been reached in support of the V-22. (Osprey fax, 1994, p. 2)

The V-22 Program is finally moving toward production, four production-representative aircraft are being constructed at Bell and Boeing, and as previously mentioned, a new contract for the EMD phase of production aircraft is in place. A final go ahead for a limited production of aircraft is anticipated during the Fall of 1994.

E. BELL-BOEING'S VISION OF TILT ROTOR TECHNOLOGY

Numerous DoD COEAs as well as additional Government studies have been conducted on the MLR. All have concluded that the V-22 is the preferred solution.

> The V-22 is the preferred solution for the MLR. It is time to formally endorse the V-22 for this urgent Marine requirement, to produce the Osprey for our Naval and Special Operations forces and to accumulate the military fleet experience that will open the way for realization of the civil applications and economic benefits of this revolutionary American technology. (Osprey fax, 1994, p. 1)

There are many points of view for the acquisition of the V-22. Congress has been a strong supporter of the program; while initially the Administration was also a supporter, it is no longer in favor of procuring the V-22.

The Bell-Boeing team believes that the future importance of tilt rotor technology will go well beyond the V-22 program. Bell-Boeing firmly believes that organizations such as the Joint Requirements Oversight Council (JROC) and DoD as a whole should take into consideration future commercial sales of the V-22 when deciding what will meet medium lift requirements for the Marine Corps. Bell-Boeing believes these dimensions include not only the application of tilt rotor's unique capabilities to varied missions performed by DoD or other U.S. Government agencies, but also to the unprecedented foreign military and ultimately civil market potential for the V-22 or other derivative tilt rotor aircraft. Estimates vary but the civil market potential for tilt rotor technology is estimated to be $125-150 billion in U.S. economic activity over the first decade of market entry. It can be argued that no other current naval program has such a huge potential for benefit to the American economy and in particular the American Aerospace industry. (Osprey fax, 1994, p. 3)

F. SUMMARY

The history of the V-22 program was presented in this Chapter in order to provide an understanding of the many complex issues surrounding the troubled history of the V-22. Additionally, Bell-Boeing's vision of tilt rotor technology and its civil

applications and benefit to the U.S. economy were discussed. Chapter IV will introduce the Joint Program Office which represents the Bell-Boeing team. An analysis of the Joint Program Office will be presented along with the acquisition strategies of the Joint Primary Aircraft Training System and the F/A-18 program.

IV. AVIATION PROGRAMS AND PROCUREMENT METHODS

A. INTRODUCTION

Chapter III discussed the origin and the program management history of the V-22 Osprey. A chronology of the program was presented with emphasis on DoD's efforts to cancel the program during the latter part of the 1980s and Congress' intent to keep the program alive. Chapter IV will analyze the Joint Program Office established by Bell-Boeing and its ability to represent the companies to the Government. Additionally, the Chapter will look at the Joint Primary Aircraft Training System and the F/A-18 program.

Numerous interviews were conducted with Government and Bell-Boeing officials. The intent of the interviews was to obtain opinions and insight into the Bell-Boeing teaming arrangement. Interviews cited within this thesis are composite views of opinions and findings of those interviewed. It must be noted that during interviews with the Joint Program Office, industry officials felt that much of the information requested by this researcher was of a proprietary nature and would not be released. Specific types of information requested included the teaming agreement signed by Bell and Boeing, job descriptions of positions within the Joint Program Office, and the overall organizational structure of the Joint Program Office. Therefore, examination of the V-22 JPO for this thesis has been limited by the parent companies.

B. OSPREY/V-22

1. Parent Companies and JPO

A significant question this researcher had concerning the Bell-Boeing Team was why did Bell and Boeing choose each other to form a team for V-22 procurement? According to company officials both companies were working on tilt rotor technology and both companies were involved in the XV-15 tilt rotor demonstrator. Bell Helicopter had been awarded a contract by the Department of the Army and NASA for XV-15 development in 1972. The XV-15 was a follow-on program to Bell's XV-3 tilt rotor program of the 1940s and 1950s. Later, Boeing was awarded a NASA contract to develop advanced technology composite proprotor blades for the XV-15 in 1981. In May of 1982 a formal teaming agreement was signed by Bell Helicopter, Inc. and Boeing-Vertol Company, which became Boeing Helicopter, Inc., to compete for production of the upcoming Joint Services Aircraft Program (JVX). According to a Boeing official within the JPO, since the Government desired that a JPO be established

to represent the two companies, the Government preferred to have a large company teamed with Bell for this project (Interview with Anonymous Source, 1994). Conversely, according to a Bell official within the JPO, Bell was looking for a partner with which to share costs. Bell felt that there would be significant profits to be made from the military and commercial applications of a fully developed tilt rotor aircraft.

Although Bell-Boeing officials within the JPO felt that the relationship between the two teams was a good one, there were still problems with the teaming arrangement. For example, the teaming agreement called for a 50/50 split for project and contract performance, therefore Bell and Boeing had to be in agreement on all decisions. Another key point of the teaming agreement calls for a 50/50 profit split, however each company is independently building separate portions of the aircraft. Bell is building the wing, rotors, empennage, and nacelles while Boeing is building the fuselage, flight controls, software and they are also the systems integrator for the cockpit and landing gear. Depending on who was being interviewed at the JPO, the general feeling was that their particular company had a larger share of the work effort and should therefore be compensated accordingly.

It should be noted as stated in Chapter I under the FSD contract, Bell was to be responsible for the wing, nacelles, propulsion and dynamics, while Boeing would assume responsibility for the fuselage, empennage, avionics and flight controls. However, the acquisition strategy has changed and now the Bell-Boeing team will not be split as was originally planned. The two companies will remain as a team producing separate portions of the aircraft. According to anonymous Government officials, non-recurring costs such as tooling to set up two separate production lines for the V-22 would be cost prohibitive. The general feeling now among Government officials working on the V-22 procurement is that dual-sourcing of large and complex weapon systems is not a good idea. One of the primary reasons to dual-source a project is to build competition into a procurement which should lead to efficiencies among the contractors resulting in lower prices to the Government. However, as the V-22 program has progressed and aircraft quantities to be produced have decreased, per unit product costs have increased significantly making dual-sourcing economically infeasible (Interview with Anonymous Government Official, 1994).

The team members independently producing separate sections of the aircraft, drive decisions as to where a particular major component will be built. A Work Breakdown Structure (WBS) is used to identify which company has responsibility for

subsections and assemblies of the respective major components. According to Government officials, the Government along with the JPO monitors this process to ensure that the work split remains equal. This is a management control feature the Government and parent companies use to balance the level of effort between parent companies.

The Joint Program Office is a small organization consisting of personnel sourced from both companies. According to company officials, the staffing for the JPO was only to be temporary with specific personnel working within the JPO for a relatively short time. At the end of their assignment at the JPO, personnel were to transfer back to their respective companies. However, according to Government sources, certain engineering personnel joined the JPO at its inception and are still working there. There now appears to have been a significant turnover in personnel at the JPO under the new EMD contract from those personnel that worked on the project under the old FSD contract. (Interview with Anonymous Government Source, 1994)

The lines of authority that existed previously within the JPO continue to exist today under the EMD contract. JPO personnel still report back to the parent companies causing increased time for coordination and decision making which continues to be a problem for the Government. This is to be expected since this is a team and not a joint venture. The JPO staff currently includes the Program Manager, a Boeing employee, and the Deputy Program Manager, a Bell employee. These positions may be staffed by either company but according to Boeing program officials the Program Manager will always be a Boeing employee. Boeing feels that the size of their company in relation to that of Bell, along with their position in the industry, justifies their leadership of the JPO. On the other hand, Bell officials feel that since their company has been involved in tilt rotor technology since the 1940s, this justifies their leadership in this area of aviation and they should lead the JPO. According to Government officials, the Government also has influence as to who will lead the JPO and at this time is satisfied with its organization.

A Government official commented that there was a startling difference in management philosophies of the two companies, Bell and Boeing. The V-22 was a much bigger contract than either had previously attempted. There were differences in the approach to doing business. Textron, Bell's owner, was concerned with minimizing short-term losses. Boeing Corporation was a long-time aircraft

manufacturer that knew the industry requirements of long-term investment; usually resulting in losses in the early years of a project. (Smith, 1989, p. 35)

The company's cost schedule control systems were also different. Bell charged proposal preparation to overhead while Boeing charged the preparation directly to the individual contract. Boeing had a somewhat structured management hierarchy that seemed to restrict the flow of information within the company. Bell, less structured, had a more free flow of information. The program was a quantum leap from the million dollar projects of which they were accustomed to the billion dollar V-22 effort. (Smith, 1989, p. 36)

Company cultures were also discussed with Bell-Boeing officials. It was stated that it would be hard to find two companies with more adverse corporate philosophies. Boeing seemed more concerned with schedule where Bell was concerned with cost. It was stated there seemed to be a lot of short-term motivation in a long-term industry and that this problem was becoming more common in the aerospace industry today. The Government is concerned with affordability while corporate stockholders look at this year's profits and demand a respectable return on investment. (Smith, 1989, p. 36)

Bell-Boeing also admitted to difficulties in gauging progress in the early stages of the program. Because Bell made the wing assembly and Boeing the fuselage, interaction was a source of frustration, especially when interfacing the parts. If the mate was off an inch, it presented the problem of finger pointing as to who was at fault. (Smith, 1989, p. 37)

2. Integrated Product Teams

As a means of coordinating V-22 production, Bell-Boeing is using Integrated Product Teams (IPTs). According to JPO officials, the use of IPTs is growing within the aviation industry. Product organized IPTs are new to the EMD contract and appear to be working well for the contractors, according to Government officials. The breakdown of work corresponds to the requirements specified in the EMD contract. For example, the V-22 is broken down partially as follows:

- Air Vehicles
  - Air Vehicle—Philadelphia, PA
    - Crew System
    - Airframes and Systems
    - Avionics
    - Vehicle Systems

- Hardware Components
- Requirements
- Integrated Test Team – Patuxent River, MD
- Shipboard
- External Loads
- Airframes and Systems – Fort Worth, TX
  - Assembly Build
  - Wing
  - Rotor
  - Drive System
  - Propulsion
  - Subsystems and IWS
  - Empennage and Ramp

As previously mentioned the IPTs seem to be working well. However, a possible problem with the IPT organization is the Integrated Test Team located at Patuxent River, Maryland. Prior to the EMD contract Bell and Boeing maintained separate facilities with each company conducting its own Testing and Evaluation (T&E). According to Government officials, this was an inefficient means of conducting T&E. Test results were not communicated in a timely manner to the other team member. Now under the EMD contract Bell and Boeing have established a single Integrated Test Team staffed by both the parent companies.

The Naval Aviation Maintenance Program (NAMP) has been established within Naval Aviaiton as a means of coordinating and controlling the effort of work on aircraft. The NAMP calls for a matrixed organizational structure. This structure provides for an Aircraft Maintenance Officer supported by functional areas such as quality assurance, airframes, power plants, avionics and life support systems. An integral area within the NAMP is the Maintenance Control Section. As its name implies, Maintenance Control is the central point for control and documentation within a Naval Aviation Squadron. The NAMP is a well-established system which provides for a means of controlling and documenting the maintenance effort on Naval Aircraft.

In contrast to the NAMP, the Integrated Test Team has no similar organization. According to Government officials, they do not readily see any control or coordination at the integrated test site. Although no major problems have occurred which can be

attributed to lack of organization at the test site, the Government does not have full confidence in the management of the Integrated Test Team.

C. JOINT PRIMARY AIRCRAFT TRAINING SYSTEM

A brief overview of two other aviation programs will now be presented for comparison: the F/A-18 program, currently in production and the Joint Primary Aircraft Training System (JPATS) which is awaiting production. The JPATS will likely be a teaming arrangement such as Bell-Boeing's while the F/A-18 is being procured under a prime-subcontractor relationship. This overview is presented to highlight that teaming is still considered a viable means of procurement within DoD while the more traditional prime-sub relationship, which has advantages over teaming, also continues to be used

The world's aerospace industry is anticipating the competition for DoD's JPATS, which could likely provide the winners with the chance to build upwards of 1000 aircraft along with a proportionate number of ground-based training systems and ancillary equipment.

The United States Navy and Air Force use a primary training aircraft to train entry-level student aviators in the fundamentals of flying so they can transition into advanced training tracks leading to qualification as military pilots, navigators, and Naval Flight Officers (NFO). Both Services currently employ primary training aircraft with 1950s technology. These aircraft, the Navy's T-34C and the Air Force's T-37B, are operationally outdated and increasingly limited in training the skills required in follow-on aircraft. (Operational Requirements Document, 1993)

JPATS will replace the T-34C and the T-37B in undergraduate Naval and Air Force pilot training, NFO training, and navigator training. JPATS may also support European-NATO joint pilot training.

The 1989 DoD Trainer Aircraft Masterplan identified the need and opportunity for the Navy and Air Force to replace their T-34C and T-37B with a common acquisition of the Joint Primary Aircraft Training System. JPATS will employ aircraft, simulators, associated ground-based training devices, software, data management systems, courseware, and logistics support. The components of JPATS (aircraft, simulators, and other ground-based training devices) shall be common. Each Service will tailor logistics support to its individual needs and achieve efficiencies within its own infrastructure. Total contractor logistics support shall be required for all

components of each Service's ground-based training system. (Operational Requirements Document, 1993)

It is interesting that production of JPATS will most likely be accomplished through a teaming strategy. This has occurred due to the U.S. military's demand for an off-the-shelf airframe which has meant that all but one of the seven known contenders for the airframe were designed in other countries. All have been substantially redesigned by U.S. companies in collaboration with the original designers to meet U.S. military requirements. Also, because of the need for a high U.S. work content those destined for the U.S. military will be almost entirely produced in the U.S. (Teams Line Up for 1994 JPATS Showdown, 1993, p. 3)

Of the seven contenders for the airframe, currently there are six teams and one sole producer competing to produce the JPATS. The contenders are Beech/Pilatus, Grumman/Agusta, Lockheed/Aermacchi, Northrop/Embraer, Rockwell/Dasa, Vought/FMA, and Cessna.

Beech Aircraft Corp., a Raytheon company, has teamed with Swiss aircraft manufacturer Pilatus to develop the turboprop PC.9 Mk. 2 for the JPATS program. Grumman Corp., teamed with Agusta of Italy, has developed the S211A, an improved version of an aircraft originally aimed at an earlier U.S. Air Force trainer competition, into a mature, reliable and easily maintainable airborne classroom for the JPATS competition. (Teams Line Up for 1994 JPATS Showdown, 1993) Lockheed Aeronautical Systems Company teamed with Aernautica Macchi of Italy to produce the MB.339A as their JPATS competitor. Northrop Corp. has teamed with Embraer of Brazil to produce the Embraer Super Tucano 2 for their entry into the JPATS competition. Rockwell International's North American Aircraft Division is teamed with Deutsche Aerospace of Germany to develop the Ranger 2000 for the JPATS competition. These two companies are also aiming to integrate the aircraft with a ground-based training system embodying concepts already developed by Rockwell. Vought Aircraft Company teamed with FMA of Argentina to develop and propose the Pampa 2000 Trainer for the JPATS mission, also has established links with AlliedSignal, which will produce the engine and many subsystems for the aircraft. Cessna Aircraft Company, a subsidiary of Textron, Inc., is the only competitor proposing an indigenous U.S. design, as well as the only design adapted from a civil jet aircraft, the Cessna CitationJet business aircraft of which two prototypes are currently in production.

Production of the winning JPATS Aircraft for the U.S. military is likely to continue for 15 years or more, or until approximately 2010. The aircraft and their associated training systems are likely to be in service for another 15–20 years. In addition, the program is expected to be used to develop and demonstrate streamlined acquisition procedures. DoD intends to make increased use of commercial acquisition practices, helping to reform the system that has been in use for many years.

The JPATS competition has taught the Air Force acquisition people new lessons about working with the commercial sector and working with an existing aircraft. Partnerships between the Government and industry and between the Air Force and Navy have also been strengthened. The group that put together the request for proposals (RFP) spent a great deal of time trying to produce as streamlined an RFP as possible. (Silverberg, 1994, p. 27)

Another notable element of this program is the high priority placed on quality manufacturing of the aircraft. In contrast to previous procurements, cost will not be the ultimate determinant. (Silverberg, 1994, p. 24) This is borne out by the selection criteria which state that while the Government will strive for maximum objectivity in making its award, subjective judgment on the part of Government evaluators is implicit in the source selection process.

The award of a JPATS contract currently expected in the spring of 1995 will start a second round of competition, this one for the Ground-Based Training System (GBTS). A GBTS award is anticipated 12–14 months after the prime contract award. The original JPATS acquisition strategy called for the prime contract bidders to pick GBTS partners and enter the competition as a team. However, in a 1992 dialogue between the Services' and the Pentagon's civilian leadership, Donald Yockey, then Under Secretary of Defense for Acquisition, changed the acquisition strategy. His primary concern was how to give the prime contractor total system responsibility when the Government was going to make the GBTS selection. This contradicted the Government's desire to hold an open competition. (Teams Line Up for 1994 JPATS Showdown, 1993)

When GBTS was an integral part of the competition, British Aerospace, Loral, and CAE-Link had all teamed up with the competitors. These companies are all as interested as before even with the change in acquisition strategy. Additionally, major training and simulation companies that were not originally teamed are eyeing the GBTS competition too. "We're in the decision-making process," said Robert O'Brien,

director of public relations for McDonnell Douglas. Also, Hughes Training "plans to be a major player in that competition," said Rick Oyler, Hughes' marketing and communications specialist. (Silverberg, 1994, p. 21)

D. F/A-18 PROGRAM

The F/A-18 Naval Strike Fighter is a twin-engine, mid-wing, multi-mission, tactical aircraft. McDonnell Douglas Aerospace Corporation (MDA) is the prime contractor and Northrop Corporation is a first-tier subcontractor (Interview with Lisa Matt, 1994). McDonnell Douglas and Northrop refer to themselves as a team, although this is not a formal teaming arrangement as is used by Bell-Boeing. The "team" of MDA and Northrop have delivered more than 1,240 F/A-18 Hornet strike fighters. The Hornet first entered operational military service in 1983. As principal subcontractor to MDA in St. Louis, Northrop produces the 26-foot-long center and aft fuselage sections, twin vertical stabilizers and all associated subsystems for the F/A-18 at its Aircraft Division facilities in Hawthorne and El Segundo, California. (Interview with Terry Claussen, 1994)

Northrop has delivered more than 1,240 F/A-18 shipsets to MDA, the program integrator, who then completes assembly of the aircraft. Northrop considers a shipset to be the center and aft fuselage and the twin vertical tails along with their associated subsystems. For the FY-93 procurement, a Defense Plant Representative Office (DPRO) official stated that MDA contributed 71% of the aircraft dollar value while Northrop contributed 29%. (Interview with Anonymous DPRO Official, 1994) However, the Northrop publicity office stated that the work split for the FY-93 procurement was 60% MDA and 40% Northrop (Interview with Terry Claussen, 1994).

As previously stated, the F/A-18 is being procured under a formal prime/sub-contractor relationship, however MDA and Northrop call themselves a "team." Since MDA is the prime contractor, they are liable for the success or failure of the program, while Northrop is content with their position as subcontractor. An anonymous MDA official commenting on the "team" of MDA and Northrop praised Northrop as a quality manufacturer with a solid reputation within the aerospace industry. For example, MDA praised Northrop for winning the Air Force's prestigious Contractor Productivity Award three years in a row for achievements on the F/A-18 program. In 1984, Northrop won the award for achievements in quality and reliability, in 1985 for cost reductions in direct labor, and in 1986 for cost reductions in materiel and subcontracts.

Designated to replace the F-4 PHANTOM and A-7 CORSAIR, the F/A-18 is employed in Navy and Marine Corps Strike Fighter Squadrons. Single and two-seat variants with a Night/Austere All-Weather capability are being delivered. The F/A-18 uses external equipment to accomplish specific fighter or attack missions. This capability offers the operational commander more flexibility in employing his tactical aircraft in changing scenarios. The primary design missions are fighter escort and interdiction with fleet air defense and close air support as additional roles. Since the same airframe, engine, flight control, and weapon systems are used on attack missions as well as on fighter missions, excellent fighter and self-defense capability is retained. One thousand eighty-six aircraft are scheduled to be built, eleven of which were prototype aircraft funded within the RDT&E appropriation. (F/A 18 C/D HORNET, 1993)

1. Engines

The Navy procured F404-GE-400 (-400) engines to power the F/A-18 aircraft beginning with the full scale development contract in 1976. The engines were procured sole-source from General Electric (GE) from 1978 to 1987. Beginning in FY-87, engines were procured competitively in a dual-source program from GE and Pratt & Whitney. The dual-source competitive contracts were approved for FY-88 through FY-92 for F404-GE-400 engine requirements. However, in FY-89 a decision was made to: (1) provide the opportunity for a split award or a 100% buyout; (2) extend the contract(s) through FY-95; (3) add FMS option line items; and (4) add option line items for Kuwait and USN F404-GE-402 (-402) engines beginning in FY-90 and FY-91, respectively. The FY-89 competition resulted in a 100% award to GE for FY-90 through FY-95. This contract contains not-to-exceed prices for the -402, the additional, unique effort to modify the -400 engine to a -402 configuration. Although competitively awarded before, competitive procurement of the FY-96 and FY-97 -402 engine requirements is not considered feasible. Acquisition using other than full and open competition under the authority of 10 U.S.C. 2304(c)(1), as implemented by FAR 6.302-1 will be employed to satisfy this requirement, otherwise substantial duplication of costs to the Government that cannot be recovered through competition would be incurred and unacceptable delays in fulfilling the requirements would occur. GE is now the sole producer. With the extensive prior investment in establishing GE's existing expertise and production capacity, GE is the only viable source to meet the Government's requirement. Firm-fixed-price contracts for FY-96 and FY-97 engine

requirements will be awarded to GE on a sole-source basis. (F/A 18 C/D HORNET, 1993)

2. Current Conditions

The F/A-18 weapon system successfully completed full-scale development and is in its production phase. McDonnell Douglas Aerospace and its subcontractors have demonstrated the capability to perform on schedule at predictable and reasonable cost. No unusual cost, schedule, capability or performance constraints are known or anticipated at this time. Projected quantities may be altered by direction of Congress and approved by the Secretary of Defense or by the addition of any Foreign Military Sales (FMS) for which Letters of Agreement (LOAs) are executed. Coordination between MDA, major Government Furnished Equipment (GFE) providers, and major sub-tier contractors is required to ensure that GFE and contractor-furnished equipment integrations are accomplished and maintained. In joint production buys, USN and FMS customers will share lower costs on items which are common to each aircraft. Items unique to the USN or a FMS customer are charged separately. The F/A-18 aircraft is outfitted with ancillary equipment which is compatible with existing armament systems. This provides the F/A-18 aircraft the flexibility of using in-stock munitions. (Interview with Lisa Matt, 1994)

MDA and GE are the only contractors that can meet the required schedule. The use of any other engine for this program would result in a substantial delay, and duplication of cost to the Government for development, logistics support, and support equipment. The current F/A-18 program contains substantial GFE, due principally to an aggressive breakout program to control cost and enhance competition. (Interview with Lisa Matt, 1994) The F/A-18C/D production program received Milestone III authority on December 1982 with no major milestone reviews remaining related to current production. The program, now a mature system, has completed Milestone III and is nearing the end of production.

3. Alternatives

Alternate acquisition approaches are not considered appropriate for the airframe, engine and training system upgrade since MDA and GE are the only viable sources who can meet the Government's requirement and schedule needs. Reinstitution of the GE/Pratt and Whitney dual-source for FY-95 through FY-97 is not considered feasible in view of the reduced procurement quantities and the cost to re-establish a second source. (Interview with Larry Rosendorf, 1994)

4. Sources

Manufacture of the F/A-18 aircraft requires an intimate familiarity with the appropriate design and engineering details, extensive production engineering, and an extended period of preparation for manufacture (Interview with Lisa Matt, 1994). MDA is the sole designer, developer, integrator, and producer of the current versions of the F/A-18 aircraft. MDA is the only firm which possesses the requisite knowledge of the aircraft's design, manufacture, operation and maintenance necessary to meet the Government's requirement. Further, the Government does not own a full F/A-18 technical data package. It would be prohibitively expensive and time consuming to procure these rights. Only MDA has adequate existing facilities, tooling, and special test equipment to perform the Government's minimum needs to provide acceptable aircraft in an accurate and timely manner. (F/A 18 C/D HORNET, 1993)

Monitoring of each contractor's production is accomplished by a series of Government management information reports. This includes appropriate Contract Funds Status Reports (CFSR), which are submitted by the contractor in accordance with DoD instructions and the Contract Data Requirements List (CDRL). Monthly progress reports and periodic business and technical reviews by F/A-18 project management officials are supplemented by daily contacts between the contractor and the Defense Plant Representative Office at each contractor's main assembly plant. Periodic audits review each contractor's internal controls. The Cost/Schedule Control Systems Criteria (C/SCSC) will not be applied to this procurement.

5. Subcontracting Plans

Special incentives for small business/small disadvantaged businesses subcontracting will be negotiated pursuant to FAR 19.708(c)(1) under individual contract actions. Under a formal "teaming" arrangement between MDA and Northrop Corporation, for each applicable procurement, Northrop will submit its own plan which will be separately reviewed and approved. (F/A 18 C/D HORNET, 1993)

GE has established a Master Subcontracting Program for small businesses and small businesses owned by socially and economically disadvantaged individuals. GE also submits specific goals for each individual procurement. These goals are then reviewed by NAVAIR before any new procurements are executed. Special incentives for small business/small disadvantaged businesses subcontracting will be negotiated pursuant to FAR 19.708(c)(1) under individual contract actions. NAVAIR is presently

involved in a process of identifying additional subcontractors who may be used by GE in the future.

E. CONCLUSION AND SUMMARY

In November of 1992 the American people elected Bill Clinton, President of the United States. A key plank of his platform was deficit reduction and the continuing decline in defense spending. As weapon systems continue to increase in complexity, their associated program costs will also continue to increase. This coupled with decreased quantities to be purchased for a given system further increases unit price of individual systems. Given the fiscally constrained environment that exists today, the acquisition of major weapon systems is becoming more politicized than ever before. The pressure for Congressmen to "bring home the pork" is increasing in direct proportion to the decrease in Government spending and in particular defense spending.

As previously discussed, the V-22 is being procured under a teaming strategy and the JPATS will likely be procured through teaming. The F/A-18 is being procured under a formal prime/sub-contractor relationship. While this does not fit the formal definition of contractor teaming as presented in Chapter II, to this researcher the arrangement appears to be a better relationship than the Bell-Boeing team. JPATS and the F/A-18 programs enjoy substantial support within the DoD as well as on Capitol Hill, while the V-22 enjoys greater support from the Congress than from DoD. The ability for these and other programs to survive during periods of reduced defense spending may be affected by the strategy employed for their procurement.

This Chapter examined the V-22 program management and in particular the JPO established by the Bell-Boeing team. The lines of authority within the JPO were discussed as well as the Integrated Product Teams, specifically the Integrated Test Team at Pax River. The JPATS was introduced to highlight the trend towards teaming within the aerospace industry. While the manufacturer for JPATS has not been selected, the winning contractor for this system will likely be a team consisting of a domestic and foreign manufacturer. The F/A-18 program was presented in order to contrast an alternate acquisition strategy to contractor teaming as used by Bell-Boeing. Chapter V will present findings, conclusions, recommendations and areas for further study.

V. FINDINGS AND CONCLUSIONS

A. INTRODUCTION

The purpose of this thesis was to look at the program management arrangement of the V-22 Osprey tilt rotor aircraft, how the Joint Program Office was organized by Bell and Boeing and how this organization represented the parent companies to the Government. This thesis has provided an overview of the V-22 program. A background of dual-sourcing of major weapon systems was discussed in Chapter II. This Chapter looked at the methods of dual-sourcing. Of the five methods presented, contractor teaming and leader-follower were discussed. The V-22 program was used as an example of teaming while the MK-48 ADCAP was used as an example of leader-follower. This Chapter explored the idea of DoD using dual-sourcing to provide competition in Government procurements which should then work to provide lower prices for the Government. The Competition In Contracting Act of 1984 has had a significant impact on the way the Government manages its procurement functions and it is now generally believed that competition lowers prices and improves product quality and dual-sourcing was intended as a means of increasing competition for the Osprey and MK-48 ADCAP torpedo.

Chapter III discussed the history of the V-22 program which traced the program's progress starting with the experimental XV-3 through the XV-15 research aircraft. Additionally, this Chapter showed how the V-22 program survived while constantly faced with continual scrutiny, cancellation and uncertainty. Attempted program cancellations by DoD were discussed as well as Congressional reactions to these attempts. Throughout this program's history, Congressional support for tilt rotor technology and its military and commercial applications has been strong.

Organization of the Joint Program Office was presented in Chapter IV. Numerous interviews with Government and Bell-Boeing officials detailed the impressions and opinions of this report. Reasons for forming a team were discussed along with the division of work between the two companies and how profits were to be divided. Sourcing of personnel to the JPO was also presented along with the general length of their assignment. Differences in both companies' management philosophies as well their cultures were discussed.

JPATS and the F/A-18 program were also presented in Chapter IV. While the selection of a contractor to build the JPATS has not been decided, with the exception of

Cessna, the producer will likely be a team consisting of both a foreign and domestic aircraft manufacturer. Like the V-22, the JPATS will probably be in production well into the next century. With this program, DoD is looking to make use of increased commercial acquisition practices which should further help reform the acquisition process. The increased use of commercial acquisition practices was a key point of The National Performance Review.

The F/A-18 currently being produced by McDonnell Douglas, with Northrop as a subcontractor, is procured under a prime-sub contracting strategy which is completely different from the V-22 acquisition. Additionally, the procurement of the F404-GE-400 engines used to power the F/A-18 was presented. These engines are currently being procured via sole-source from General Electric, although the dual-source strategy was used in FY-87. However, the dual-source strategy was canceled in FY-89 due to substantial duplication of cost to the Government which could not be recovered through competition. Similarly as was noted with the V-22 program, the original dual-sourcing strategy which was to occur by splitting the Bell-Boeing team has been canceled. Non-recurring costs made the dual-sourcing strategy unacceptable for the V-22 while substantial duplication of costs made dual-sourcing unacceptable for F/A-18 engines.

B. FINDINGS IN RESPONSE TO RESEARCH QUESTIONS

The first and last subsidiary research questions, "What is the contractual relationship between Bell and Boeing" and "Can the respective companies present a single face to the Government," were answered in Chapters III and IV. In May of 1982 Bell and Boeing entered into a formal teaming agreement which contractually bound the parent companies to each other for the manufacture of the V-22. This agreement made both companies jointly liable for the project and contract performance. With a cost-plus-award-fee contract in place during EMD, each company is paid for costs incurred during production of their respective component or assembly. However, profits are split on a 50/50 basis. This arrangement seems to have created tension between the respective contractors and the Government since each contractor is constantly aware of the levels of contribution to the project.

The teaming agreement established a Joint Program Office which was to represent the parent companies to the Government. As DoD uses Defense Plant Representative Offices to represent the Government by presenting a single face to industry, so has Bell-Boeing attempted to present a single face to the Government via the JPO. However, as numerous Government officials noted during interviews, the

JPO has not presented a single face to the Government. In several cases when questions were asked of the JPO by Government officials, representatives from the respective companies gave different answers to the same question. This created frustration for the Government which usually resulted in the Government going directly to the parent companies for information, thereby bypassing the JPO.

The second subsidiary research question was "What are the principal difficulties associated with the teaming arrangement?" According to Government sources, it is harder to deal with a teaming arrangement as opposed to a prime-sub relationship. In a teaming situation, there is usually double the amount of work to be done. In the case of the V-22, there are two production sites being used, one in Fort Worth, TX by Bell and the other in Philadelphia, PA by Boeing. This means two separate DPROs must be used for contract administration, one at each site. Contract specialists at NAVAIR told this researcher that "Everything is twice as hard." In addition, there are the two separate company's systems covering such areas as cost, estimating and management information that must be monitored and evaluated by the Government.

By maintaining the team into production, Bell-Boeing has reduced the possibility of unauthorized transfer or disclosure of technical data or trade secrets. Company officials admitted that under the initial strategy when the team was to split once the program was in production, the safeguarding of technical data and trade secrets was a primary concern to each company. Since each company's expertise lies in different areas of manufacturing, as evidenced by the work split between the two companies, under the new strategy each company will now be able to protect any trade secrets or technical data from being compromised since the team will not be split once in production.

As was mentioned in Chapter II, a possible problem with contractor teaming is that the team members may not want to split the team when the project ends. It appears that Bell-Boeing may have faced this problem since the team will no longer be split during production. The Government appears to have solved this problem for the companies; because of the high costs of establishing a second source, the team will not be split. In effect this now gives Bell-Boeing the power of being a sole-source producer and the advantages to be gained from dual-sourcing will not be realized.

The answer to the third subsidiary research question, "Can teaming facilitate performance in the best interest of the Government and the respective contractors?" appears to be maybe. As the cost of major weapon systems continues to increase and

the number of systems purchased decreases, manufacturers will increasingly find it difficult to compete in this area. One possible means of remaining competitive is contractor teaming. As companies team for major systems, this has the effect of preserving the industrial base while helping companies to remain in business. Since the V-22 program will probably cost in excess of $10 billion, teaming has allowed Bell-Boeing to assume a lesser amount of risk than had they been a prime contractor. However, as the multi-billion dollar F/A-18 program is nearing the end of its production, McDonnell Douglas Aerospace has shown that they can effectively manage risk to produce a major weapon system using a prime-sub relationship.

Lessons learned from the V-22 program:

- Dual-sourcing of large and complex weapon systems does not result in significant savings. Because of the increased costs of starting a second production line the team of Bell-Boeing will not be split.
- Personnel in a Joint Program Office maintain their allegiance to the parent companies. Since a team is not a joint venture the parent companies exercise control over their individuals in the JPO. For the V-22, this has been inefficient and time consuming.
- Joint programs such as the V-22 must receive the full support of the individual Services. Once the Army withdrew from the program the total number of aircraft to be bought significantly decreased. This lead to the increased cost of the program to the remaining Services which may help to explain Secretary Cheney's opposition to the program thereby putting the entire acquisition in jeopardy

C. CONCLUSIONS

It appears to this researcher that the acquisition of the V-22 has not been efficient. During the Bush administration, Secretary Cheney tried to kill the program in order to save costs in the short run but this strategy ran into opposition in the Congress who kept the program alive. If the V-22 continues into production, the result will be a significantly reduced number of aircraft bought and at a considerable increase in unit cost.

As we continue into the 1990s, defense budgets will remain constrained and the U.S. Government can not continue to waste billions of dollars on unneeded programs or on inefficient acquisition strategies. As the U.S. Government strives to maintain a viable national defense and an economically sound industrial base during periods of

constrained budgets, programs must be designed which can take full advantage of any potential foreign military sales and more importantly, commercial applications. This means that the V-22, while fulfilling a critical need in Naval Aviation, will also generate the technology needed for the maintenance of a strong industrial base.

There is also the consideration that if tilt rotor technology is not developed in the United States by companies such as Bell and Boeing, this capability may be lost to Japan or Europe. The Department of Defense should not be made to carry the entire burden of developing critical technologies that have direct commercial applications. Congress should look at ways of funding "critical national technologies" as a means of maintaining the United States' position in advanced technology development among world competitors.

D. RECOMMENDATIONS

If contractor teaming is to be used for the acquisition of large and complex weapon systems, one of the companies should be designated as the lead or prime team member having contractual liability for contract performance. This would place the responsibility for project and contract performance in the hands of one company. This improves accountability and relieves the Government of monitoring more than one contractor. This would also solve the problem of contractors not presenting a single face to the Government since a JPO would not be needed and the Government would monitor only the lead or prime team member.

For multi-service acquisitions, Services should not be allowed to withdraw from a program once they have committed to its acquisition. There have been numerous examples in the past of DoD acquiring and attempting to acquire weapon systems to meet the needs of more than one Service. Some of these have been successful such as the F-4 Phantom and the UH-1 Huey, while others, such as the F-111, have been failures. Without attempting to explain the success or failure of these prior weapon systems, it is clear that when more than one Service supports a program, that program has a greater chance of success. When the Army withdrew from the V-22 program, this had a significant and detrimental effect on the entire program. With the Army's withdrawal, support decreased and costs increased. It is still not clear whether the V-22 program will survive. If the program does not survive, the Marine Corps will still be in the position of trying to replace an old and obsolete aircraft with a newer and more capable system.

E. AREAS FOR FURTHER STUDY

There have been areas mentioned throughout this thesis that require additional research. Some of these are summarized below:

- The ability of the Government to successfully build competition into an acquisition.
- The effects of CICA during periods of decreased Federal spending and a shrinking industrial base.
- The funding and development of "critical national technologies" by the Congress rather than by DoD or any other executive department or agency.
- The ability of off-the-shelf products to meet the needs of military applications.

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