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THE BOEING 767 PROGRAM: A CASE STUDY OF ISSUES RELATED TO SUCCESS IN MANAGING AN INTERNATIONAL COOPERATIVE PROJECT

THESIS

Michial G. Farrell
Major, USAF

AFIT/GLM/LSP/86S-18

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Michial G. Farrell, B.S., M.S.
Major, USAF

September 1986

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— Michial G. Farrell

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Abstract

During the past 15 years, international cooperation has become the dominant business strategy among the free world's commercial airplane and jet engine manufacturers. International cooperation is being used to reduce risks, improve market access, reduce competition and rationalize resources. This trend toward forming international partnerships to develop new commercial airplanes and the engines to power them is expected to continue.

The purpose of this study was to contribute to the understanding of how specific management techniques and policies affect the success of an international cooperative program. The research identified factors which could have a significant influence on the successful management of such a program.

The Boeing 767 airplane program was selected for a case-study analysis. The methodology and research hypotheses developed by Charles M. Farr were replicated during this research. Personal interviews with knowledgeable executives from the Boeing Commercial Airplane Company were conducted. The research hypotheses were evaluated based on data from the interviews and secondary sources (when possible).

Based on the case-study analysis as well as the research literature, conclusions regarding the management factors addressed in the research hypotheses are stated, and several principles for managing an international cooperative program are reiterated.

THE BOEING 767 PROGRAM: A CASE STUDY OF ISSUES RELATED TO SUCCESS IN MANAGING AN INTERNATIONAL COOPERATIVE PROJECT

I. Introduction

The purpose of this research study was to learn more about the art and science of managing an international cooperative project to develop and produce a commercial airplane. Specifically, the research effort focused on the Boeing 767 aircraft program. The study contributes to the understanding of how management techniques and policies affect the success or failure of an international cooperative project.

Chapter Overview

This chapter identifies the general issue, the specific research problem, the research hypotheses, the scope of the research and a justification for the research. The chapter concludes with a brief general background on international cooperation in the commercial airplane industry.

General Issue

International cooperative projects represent an extremely complex business strategy. The significant political and economic implications of this strategy are

generally perceived to be accompanied by a higher than normal degree of management risk. U.S. corporations are currently involved in numerous international cooperative projects, but very little has been written about project management under these complex and risky conditions.

Research Problem

This research aims to identify factors which appear to contribute to success in international cooperative projects in the commercial airplane industry. An international cooperative project will be defined as the nonrepetitive transfer of technology (material, information and capacity) across international boundaries among risk-sharing organizations. Success will be defined in terms of (1) the ability to meet or exceed stated cost, schedule, technical and offset performance goals; (2) the non-withdrawal of any partner(s); and (3) perceived success as expressed by key people knowledgeable about the project.

Research Hypotheses

Charles M. Farr, during his research of international cooperative programs involving weapon systems, developed ten hypotheses concerning factors which may influence program success or failure. The current research uses the same hypotheses to evaluate a commercial airplane program.

I. PROGRAM MANAGEMENT STRUCTURE:

H1: International cooperative programs guided by steering groups are more likely to be successful than programs guided by parent bureaucracies or other ad hoc organizations.

H2: International cooperative programs in which program managers are granted high levels of authority are more likely to be successful than programs in which program manager authority is more limited.

H3: International cooperative programs of larger size are more likely to be successful than projects of smaller size.

H4: Programs in which participants' requirements and goals are carefully harmonized at the outset will more likely be successful than those in which requirements/goals are not harmonized.

II. TECHNOLOGY RELATED FACTORS:

H5: International cooperative programs which attempt few and modest advances to the state-of-the-art are more likely to be successful than programs which attempt multiple and major advances.

H6: International cooperative programs in which each partner's share of technological benefits is perceived as being in proportion to its contribution are more likely to be successful than programs in which shares are not so perceived.

H7: Programs in which participants have relatively more experience with international programs and with the relevant technology will more likely be successful than those in which participants have less experience.

III. CONTEXTUAL ENVIRONMENT:

H8: International programs whose program managers and team members are more program oriented than parent [company] oriented are more likely to be successful.

H9: Programs in which there is less environmental uncertainty will more likely be successful than programs which experience more uncertainty.

H10: Programs which are structured to minimize uniquely international concerns such as geographical

separation, cultural differences, language barriers, etc., will more likely be successful than programs that do not minimize such concerns.

Scope of the Research

The literature review of Chapter III provides an extensive general background on international cooperative programs in the commercial airplane and engine industry. But the research findings of this study are limited to information gathered specifically about the Boeing 767 program. (Some information pertaining to the Boeing 7J7 program is identified and reported separately in Chapter IV. However, no conclusive findings are reported.)

The research findings are limited to the Boeing 767 program because an in-depth study was necessary in order to learn what specific management practices were employed. The findings cannot be generalized beyond the 767 program, but can be added to the data base started in Farr's research.

Justification

There are two principal reasons why this study should be of some interest to the U.S. Department of Defense (DoD). First of all the DoD has been involved in a number of international cooperative projects. The information gathered in this study contributes to understanding how management practices may influence the success or failure of an international program. Secondly, the U.S.

commercial airplane industry represents a significant element in the U.S. defense industrial base. There is some evidence which indicates that U.S. airplane manufacturers may be facing a serious threat to their future competitive ability (2; 15).

Background

In the early 1970s, four wide-bodied jet aircraft entered commercial passenger service. The Boeing 747 entered service in 1970, followed by the McDonnell Douglas DC-10 in 1971, the Lockheed L-1011 in 1972 and the Airbus Industrie A300 in 1974 (12:119-136). The huge development costs and slow initial sales of these airplanes had varying effects on their manufacturers.

Boeing came very close to bankruptcy but was saved by sales of its 727 and 737 airplanes. McDonnell Douglas' "civil aircraft division has only recently ended years of losses." Lockheed decided in 1981 to end L-1011 production and the company "has abandoned civil aviation." Airbus Industrie's prospects for reaching a "break-even" point in the A300 program are questionable (3:23-25).

In the years since the early 1970s, the only new (non-derivative) large commercial passenger airplane to be developed in the free world without an international cooperative agreement has been the Boeing 757. International cooperation has become an accepted strategy for

reducing both the investment and the economic risk required to develop and launch a commercial airplane. Boeing, the Japan Aircraft Development Corporation (JADC) and Italy's Aeritalia collaborated on the 767 program; Boeing and JADC are also partners in the 7J7 program; the European consortium Airbus Industrie has developed the A300 and the A310 series, and the partners are also collaborating on the A320 program; McDonnell Douglas has been actively seeking an international partner to launch a new airplane for several years.

While international cooperation is viewed as a way to reduce investment and economic risk, international partnerships also present managers with a new set of problems and challenges. Moxon and Geringer summarized some of the realities of international cooperation in general, and Boeing's situation in particular:

> All partnerships involve a split of manufacturing responsibilities, but design, engineering, and marketing tasks are not always shared. New competitors generally develop manufacturing skills earliest, and are often anxious to expand their capabilities by participating in the design of the new product and in contracts with potential customers. They are suspicious of being relegated to a subcontracting role if they view these additional skills as the keys to success in the industry. Of course, they wish to absorb such skills at the lowest possible costs. Larger firms have the opposite view, being wary of creating a potential future competitor and wishing to gain the benefits of partnership--cash and market access--at the lowest price. They must give the smaller firms enough to keep them in the deal, but they are cautious about giving them too much. In Boeing's risk-sharing venture with the Japanese and Italians, for example, Boeing did all the basic design, leaving only detailed

> manufacturing to the partners. Boeing also insisted on receiving an extra portion of project revenues for its contribution of accumulated technological and marketing skills. Boeing may have to give more responsibility to partners on future programs, however. In a proposed deal with the Japanese to develop a future plane [the 7J7] Japan has insisted on being included in development and marketing. (16:59)
>
> The Japanese have been potential partners for virtually all aircraft and engine manufacturers. Deals have been discussed with Airbus, Fokker, McDonnell Douglas, and Boeing regarding development of an airframe for the 150 seat transport, each opportunity containing a different set of plusses and minusses for the Japanese. Boeing is the industry leader and offers the attraction of partnership in a successful product. It therefore drives a hard bargain with regard to program control, participation shares, and technology transfer. McDonnell Douglas and Fokker are weaker and more in need of a partner to proceed. (16:61)

A Department of Commerce study of competition in the civil aircraft industry cited management as "a key strength" of U.S. manufacturers. "The one strength of the U.S. industry that observers continually come back to is its management" (15:112). The objective of the current research effort was to learn how Boeing management dealt with the challenges of the 767 program.

II. Literature Review

> As an international program, its managers must contend with the expected problems of differing language, culture, tax structure, business and accounting conventions, geographical separation and government. As a technology effort, particularly a research or development project, it faces the conditions of high technological uncertainty, one-of-a-kind nature, and relatively short life. As a cooperative effort, the differing goals, strategies and procedures of two or more coequal "partners" directed at a specific end product challenges managers daily just to "keep on cooperating." (10:13)

International cooperation has apparently become the dominant business strategy of the free world's commercial airplane manufacturers. During the 1970s and the 1980s, only one large (more than 100 seats) commercial airplane (the Boeing 757) has been newly developed without international cooperation among risk-sharing partners.

The initial cost of developing and producing a new large commercial passenger airplane is roughly $3 billion, and to develop and produce an efficient turbofan engine to power the airplane also costs approximately $3 billion. These costs plus other risks associated with the industry, coupled with a desire for aircraft technology on the part of nations reindustrialized since World War II, have undoubtedly given a boost to the strategy of international cooperation.

In spite of this, the research literature to date pertaining to international cooperation in the commercial

airplane industry is extremely limited. Most of what has been written about international cooperation in the commercial airplane industry focuses on the international nature of a program and why the international partnership was formed. Next to nothing has been written thus far about how a commercial airplane program was managed.

Chapter Overview

Charles M. Farr conducted research involving case studies of international cooperative weapon system projects for his 1985 doctoral dissertation. His study focused on identifying factors which "appear to contribute to success or failure in the management of these program types." In addition, he investigated the following three research questions in order to provide some necessary background information (10:4-6):

1. "What is an international cooperative project?" How do we define it?

2. "To what extent are international cooperative projects being used? What trends are apparent or expected in [the] coming years?"

3. "Why participate in international cooperative projects?" What are the advantages and disadvantages?

This chapter will answer these same questions, but with respect to the commercial airplane industry. In addition, the chapter summarizes the findings of major studies on international cooperative projects.

The purpose of this chapter is to provide a general understanding of international cooperative programs in the commercial airplane industry. This will provide a background for suggesting the research hypotheses.

International Cooperative Project Defined

Using the knowledge gained from an investigation of several branches of literature, Farr defined an international cooperative project as the "non-repetitive transfer of technology across international boundaries among collaborating organizations" (10:14). Common characteristics of international projects include (10:18):

- technology exchange
- shared investment
- multiple partners that jointly participate in the work
- shared access to new or expanding markets
- occurs anywhere on a continuum from . . . [research and development] to production
- a written agreement specifying the terms and conditions of the project
- the agreement may be government to government, industry to industry, or a combination

Research into international cooperative projects in the commercial airplane industry reveals an enormous concern for another common characteristic--shared risk. Partners in the international cooperative projects launched thus far are apparently contractually required to share in all the risks. These include cost risks, technological risks and market risks.

Cost Risk. A number of various sources estimate the cost of developing and launching a new large (more than 100 seats) commercial passenger airplane as approximately $3 billion--$1.5 billion for development and another $1.5 billion to initiate production. The costs of developing and producing a new engine for a large commercial passenger airplane are very similar to the costs for the airplane itself.

> In short, launching a new large transport is equivalent to betting the company on a high risk project for a rate of return that could be realized from investment alternatives with much lower risks. (15:58)

"The cumulative cash flow reaches a negative $2.5 to $3.0 billion level around five years after the project is initiated," and this is about the time when the first production aircraft are being delivered to the customers (15:58).

> Only a few U.S. firms have the technical expertise to design and manage assembly of the complex aerodynamic, propulsion, and electronic systems that characterize the advanced, high-performance commercial aircraft of today. Moreover, among the firms with the technical capability, probably only two or three have sufficient financial resources to independently invest up to $3 billion and remain financially sound until the breakeven point (which may be as long as 12 years) is reached. Risks of such proportions are rarely encountered in other industries. (15:49)

Technical Risks. The commercial airplane industry is an acknowledged leader in the development of advanced technology. Over the years, due to the extreme competitiveness within the industry, both customers and fellow

manufacturers have forced airplane manufacturers "to push the technology as far as possible" (16:57).

The development of a new commercial passenger airplane usually incorporates a new "leading edge" type of technology. This entails developing and producing an end item with technological advances which have never "been fully tested in actual planes or engines." As a result, "technological uncertainties are partially borne by customers, but manufacturers are sometimes forced to give performance guarantees that increase the risks even more" (16:57).

Market Risks. The research literature strongly indicates that "market-based uncertainties" are "of greater concern than technological risks" (16:57). This hardly seems surprising however, if one considers the major characteristics of the commercial passenger airplane industry. These characteristics are such that manufacturers are "cursed by long lead times, low unit volumes and a volatile business cycle among its customers" (15:24).

The time required, from the initial decision to launch a new aircraft development program until the first delivery of that aircraft to a customer, is generally five to six years. Market conditions may change drastically during this span of time, and a manufacturer's peak investment in a program can be expected to occur at about the same

time as the airplane is first entering service. At this point, the manufacturer has roughly $3 billion invested in a project designed to produce an airplane whose market demand was initially forecast even before the launch decision of five or six years ago.

Even if the program is very successful, it will take years to recover the initial investment and reach a "break-even" point. A Boeing study has stated:

> Commercial aircraft program profitability is very dependent on the number of aircraft produced of a given model. A significant number of aircraft must be sold before a program reaches breakeven, and the magnitude of program profit ultimately realized depends upon the number of aircraft produced and sold beyond that point. Accordingly, a small erosion in market or total aircraft sold results in a substantially higher percentage erosion in profit. (2:20)

According to McDonnell Douglas' Director of Collaborative Programs, Mr. Michael Favier, "Airplanes are not a mass-market item. It is a limited market that numbers in the hundreds at most. There's a finite need" (21:38).

The market's need may not be as great as was envisioned when the program was launched, due to the historically volatile world airline business. "Planes optimized for one set of assumed conditions are less attractive under alternative scenarios." Business cycles, competition, government regulation (and deregulation) and changing fuel prices are just a few of the conditions which affect the market demand for airplanes. Most recently, "declining fuel prices have reduced the operating cost

advantages of the newer jets" (16:57). In the late 1970s, when the Boeing 767 program was just getting started, who would have forecast this sharp drop in fuel prices?

Such uncertainties undoubtedly account for much of the industry's track record.

> Of the 11 American and 12 European airliners which have entered service in various permutations since the jet age began in 1952, only half-a-dozen at most--all American--have recovered their investment. (3:24)

"The formation of multinational partnerships is . . . an attempt by industry participants to limit these economic risks" (16:57).

Thus the literature related to international cooperation in the commercial airplane industry suggests the following revised definition of an international cooperative project: A NONREPETITIVE TRANSFER OF TECHNOLOGY ACROSS INTERNATIONAL BOUNDARIES AMONG RISK-SHARING ORGANIZATIONS.

In this context, technology should be considered to mean material, information and/or capacity.

Extent of International Cooperative Projects

The development of a new aircraft, as opposed to derivative models of existing designs, is extremely risky given the existing world market conditions. In the last fifteen years, the only new large (capacity in excess of 100 seats) commercial aircraft developed in the free world

without international risk-sharing partners has been the Boeing 757. This airplane was originally intended primarily for sales in the U.S. domestic market, which needs to replace its aging fleet of Boeing 727s (13:222-223). (The Boeing 737 and 747 series, and the McDonnell Douglas MD-80 and DC-10 series are all derivatives of aircraft originally developed in the 1960s. The Boeing 767 and the Airbus A300, A310 and A320 series have been developed and produced by international risk-sharing partners in cooperative projects.) These facts alone significantly underscore the extent to which international projects are being used in the commercial airplane industry today.

The following is a partial listing of international cooperative projects in the commercial airplane industry. These programs are currently in development or production, or their products are already in service.

Large Airplanes.

1. Airbus Industries A300, A310 and A320 passenger airplanes. The codevelopment partners, their home countries and their approximate shares are Aerospatiale (France) 38 percent, Deutsche Airbus (West Germany) 38 percent, British Aerospace (United Kingdom) 20 percent, and Construcciones Aeronauticas (Spain) 4 percent. Airbus is a French consortium which "exercises management control over the project." "Engineering and manufacturing are handled by member companies but marketing is done by

Airbus." The actual workshares have varied on the different airplanes. Workshares on the A320 are approximately 37 percent for Aerospatiale, 31 percent for Deutsche Airbus, 26 percent for British Aerospace and 6 percent for Construcciones Aeronauticas (16:56). The A300 and A310 are currently in production and service and the A320 is scheduled to be rolled out in 1988 (5:45).

2. Boeing 767 passenger airplane. The codevelopment partners, their home countries and their approximate share are the Boeing Commercial Airplane Company (United States) 70 percent, Japan Aircraft Development Corporation (Japan) 15 percent and Aeritalia (Italy) 15 percent. The Japan Aircraft Development Corporation (JADC) is a "government sponsored partnership" composed of Mitsubishi Heavy Industries (40 percent), Kawasaki Heavy Industries (40 percent) and Fuji Heavy Industries (20 percent). "Boeing handles all basic design and marketing, and supervises the detailed engineering," and maintains overall management control of the 767 program. The Japanese and Italian partners are generally characterized in the literature as "risk-sharing subcontractors to Boeing." The concept of operations being used on the 767 program dictates that Aeritalia and JADC manufacture the parts in their home country and ship them to Seattle, Washington. Boeing is then responsible for the final assembly of the aircraft. The Boeing 767

has been in service since 1981 and production is continuing (16:56).

3. McDonnell Douglas MD-82 passenger airplane. The participating partners are McDonnell Douglas (United States) and Shanghai Aviation Industrial Corporation (Peoples Republic of China). The project is generally characterized as a coproduction effort since the MD-82 is an existing derivative of the DC-9 aircraft originally developed in the 1960s by the Douglas Aircraft Company. The agreement calls for a small portion of the manufacturing to be done by Shanghai Aviation, but the major coproduction effort is the final assembly of twenty-five airplanes in China. The airplanes are being purchased by "the aircraft procurement subsidiary of the General Administration of Civil Aviation of China." The first aircraft is scheduled to be rolled out in 1987, with production to be completed in 1991 (22:31).

4. Concorde Supersonic Transport (SST) passenger airplane. The aircraft was codeveloped by British and French firms under government sponsorship beginning in the 1960s. Separate management organizations and production lines often worked at odds with one another. Successive British governments were tempted to cancel the program. The aircraft is currently in service but production ended before the "break-even point" was reached (13:193).

5. Boeing 7J7 passenger airplane. The codevelopment partners who have signed memorandums of understanding thus far are the Boeing Commercial Airplane Company (United States), the Japan Aircraft Development Corporation (JADC - Japan), Short Brothers (Northern Ireland) and Saab-Scania (Sweden). JADC "has become a full equity partner in the 7J7 with a 25% interest," but other shares have not yet been decided on. Boeing has guaranteed that it will maintain at least a 51 percent share of the project. The aircraft design has not been finalized and a decision for a "formal launch of the program is anticipated for mid to late 1987. In-service date of 1992 still is Boeing's target." At this point, the concept for the aircraft is still very flexible, but the current proposal is for an advanced technology 150-seat transport powered by propfan engines (6:32).

Commuter Airplanes.

1. ATR 42 turboprop commuter transport. The codevelopment partners, their home countries and their approximate workshares are Aeritalia (Italy) 50 percent and Aerospatiale (France) 50 percent. "Engineering and manufacturing are split equally between the two partners" as are the sales revenues. Major assemblies and parts are designed and manufactured by both companies, with final assembly being done in France. "Marketing is done

jointly" (16:56). The aircraft received FAA certification in October 1985 and has begun commercial service (14:281).

2. CN-235 turboprop commuter transport. The codevelopment partners are Construcciones Aeronauticas (Spain) and P. T. Nurtanio (Indonesia). "Engineering and manufacturing are split equally between the two partners." Major assemblies and parts are designed and manufactured by both companies, and final assembly is done on assembly lines in both countries. "Marketing is done jointly, and a joint central management group supervises development and production." The aircraft received FAA certification in November 1985 and has begun commercial service (16:56; 14:281-282).

3. Saab Fairchild SF-340 turboprop commuter transport. The codevelopment partners were Saab-Scania (Sweden) and Fairchild Industries (United States). "Engineering and manufacturing are [were] split equally between the two partners." Major assemblies and parts are designed and manufactured by both companies, and "final assembly is done in Sweden." "A jointly-owned Swedish company, Saab-Fairchild HB markets [marketed] the plane, and a joint finance company offers [offered] financing to customers" (16:56). Codevelopment began in 1980 and the aircraft was FAA certified in June 1984. The aircraft is currently in service and is still in production. Fairchild Industries

withdrew from the project (as a risk-sharing partner) in November 1985 due to financial difficulties. Fairchild is currently acting as a subcontractor, but Saab-Scania is scheduled to assume full responsibility for the program in 1987 (9:23).

Jet Engines.

1. CFM56 turbofan engine. The codevelopment partners are General Electric (United States) and SNECMA (France).

> Development and manufacturing are split equally between the two partners. Each partner builds major sections of the engines, which are assembled and tested in both the U.S. and France. (16:56)

The partners use a jointly owned but independent management entity, CFM International, to "handle sales and overall administration." The engine is being used to re-engine McDonnell Douglas DC-8s and Boeing KC-135s and has been selected to power the Boeing 737-300. This engine is also targeted for the Airbus A320 (13:186).

2. V2500 turbofan engine. The codevelopment partners are Pratt & Whitney (United States) 30 percent, Rolls-Royce (United Kingdom) 30 percent, Japanese Aero Engines Corporation (JAEC - Japan) 19.9 percent, Motoren-und-Turbinen Union (West Germany) 12.1 percent and Fiat Aviazione (Italy) 8 percent. "JAEC is a government-sponsored partnership" of Ishikawajima-Harima Heavy Industries (60 percent), Mitsubishi Heavy Industries (15 percent)

and Kawasaki Heavy Industries (25 percent). International Aero Engines is the jointly-owned company responsible for marketing as well as managing the project (16:56). This engine is intended for the new 150-seat class of transports, and the first deliveries are scheduled for 1988. It's targeted for the Airbus A320 and McDonnell Douglas MD-80 series derivatives (11:28).

3. General Electric CF6-80C2 and Rolls-Royce RB211-535E4 jet engines. The coproduction partners are General Electric (United States) and Rolls-Royce (United Kingdom).

> The two partners participate in 15% of the investment, profits, and production of each other's engines. No separate company or joint programs are created. Each produces parts for and does final assembly of each other's engine. (16:56)

While this is not a comprehensive list of international cooperative projects in the commercial airplane industry, it does demonstrate the extensive use of international cooperation as a business strategy.

Farr's research concluded more than 160 international military programs have begun since 1947--60 percent occurring since 1977, and 43 percent have begun or will begin during 1982-1986 (10:24). A rebuilt, reindustrialized Europe and Japan are no longer satisfied with being customers; they are determined "to foster and maintain high-technology domestic industries" of their own and they demand "technology sharing and access to world

markets" (13:302; 10:21). This leads to the "cooperation or no sale" stance which is just one of the reasons for participating in international cooperative projects.

Why Participate in International Cooperative Projects

A significant proportion of the research literature on international cooperative projects focuses on why commercial airplane and engine manufacturers participate in these projects. The reasons cited are numerous and will be presented here in four broad categories: risk reduction, improved market access, reduced competition and resource rationalization. These categories are by no means mutually exclusive, but are intended to clarify this discussion of the primary motives for international cooperative agreements.

Risk Reduction. As previously discussed, the inordinately high cost of designing, developing and launching a new large commercial airplane, coupled with a tremendous level of market uncertainty, make aircraft manufacturing an extremely risky business. Roughly 75 percent of the airliners introduced in the jet age have never recovered the manufacturers' investments (3:24). As observed by Mr. Michael Favier, Director of Collaborative Programs for McDonnell Douglas (21:38):

> The guy who goes it alone is going to have a harder time of it. The investment involved, especially to

> American companies, is extremely difficult. Boeing and ourselves have become involved in agreements to spread the risks.
>
> You can't bet the whole corporation on a new airplane program, which is what we'd be doing if we attempted to bankroll it ourselves. The L-1011 program brought Lockheed to its knees. None of us wants to be involved in something like that. It's a real memory in the consciousness of everybody.

The major investment required to launch a new airplane often exceeds the net worth of a single manufacturer, resulting in a risk equivalent to "betting the company." Using Boeing as another example, "the expense of developing the 747 . . . pushed the company close to bankruptcy" (3:23).

"The formation of multinational partnerships is in part an attempt by industry participants to limit these economic risks" (16:57). By agreeing to share the risks with international partners, participating companies can reduce their "front end cash flow" as well as their total investment in launching a new airplane. It is not only the large established manufacturers such as Boeing or McDonnell Douglas who are attracted to a risk-sharing partnership:

> From the viewpoint of smaller competitors, cooperation is even more attractive, as the barriers to competing on their own are formidable. Putting together the needed technological infrastructure is a long term task, and achieving market acceptance may be difficult. The home market is often small, airlines abroad may be nationalistic in their preferences, and establishing credibility with customers is difficult. Airlines may incur extra costs if their fleets mix products from different manufacturers, and they are wary of unproven products and unknown service capabilities. A new

competitor also faces manufacturing cost disadvantages because of smaller scale and less experience. A partnership helps build experience faster (albeit on only part of the airframe or engine), or allows the company to begin production at a lower point on the experience curve, or both. Finally, a small competitor faces large rivals with the capability to vigorously counteract competitive moves. Overcapacity in the industry and the high stakes involved have led to strong rivalry in which a small competitor's potential for survival is suspect. Such companies are attracted to joint ventures in the hope of building their capabilities and evolving to more prominent positions in the future, or merely in the hope of continued existence. (16:58)

With regard to the particular significance of increased Japanese involvement in international cooperative agreements to develop airplanes and engines:

> The fact that the Japanese Government has identified aerospace as one of several "priority areas" for high technology development and, within that area, the civil aircraft sector as a priority industry of the future, raises the possibility that Japan will become a major competitor in the large transport assembly business during the 1990s. (15:71)
>
> Developing its aerospace and aircraft industries offers Japan several benefits: the high value-added character of the industry would make a major contribution to the economy; the research intensive nature of the industry offers the potential for technology spinoffs; the products of this industry are major export items; and the aircraft industry itself is a major market for other high technology industries in electronics and materials. (15:71)
>
> At the moment, the industry still has a long way to go to develop an independent design and production capability or an integrated industry base covering not only airframes and engines, but also wings, aircraft components, equipment, and materials. (15:72)
>
> Japan faces a number of difficulties in achieving its aircraft industry goal, however. One problem is the small domestic market. Around 80% of any major Japanese commercial aircraft production effort would have to be exported, a difficult feat given the position of U.S. and European manufacturers in the world

> market. Achieving this goal probably requires more financial support than is currently being given--something more along the lines of the assistance provided Airbus Industries by European governments. An independent, integrated industry will also require extensive and efficient overseas marketing and after-sales servicing capabilities. These are crucial elements for the worldwide promotion and competitiveness of large transports. Finally, the industry must still close the gap in technology and in aircraft design and production experience as well as marketing and product support. (15:73)

JADC, along with the Japanese Government is clearly reducing the financial, technological and market risks of developing the Japanese aerospace industry by teaming with the acknowledged industry leader (Boeing) on the 767 and 7J7 programs. This risk reduction occurs not only because investment and technology are shared, but also because access to protected foreign markets may become easier.

Increased Market Access. Aside from the U.S., most of the world's major airlines, aircraft manufacturers and jet engine manufacturers are either owned, controlled, operated or subsidized by the government of their home country. Decisions regarding the purchase of new airplanes by foreign airlines are frequently very political in nature. Airplanes which have some local content, or which include a local company as a program partner are generally acknowledged to have enhanced access to a market, and therefore a better chance to penetrate that market.

> The key to cost competitiveness on an aircraft or engine program is the number of units produced. Large production runs allow the spreading of fixed

development costs and the lowering of variable costs through accumulation of manufacturing experience. Program volume is so crucial that only products capturing a significant portion of the world market can be economically successful. (16:58)

Increases in the minimum efficient scale of operations (program volume needed to break even) could increase both the amount of resources required (relative to a firm's size) and the importance of securing access to export markets. It is difficult to document an increase in the minimum efficient scale for aircraft manufacture, although comments from industry participants indicate that such an increase may have occurred. (16:60)

The importance of foreign markets cannot be overlooked by <u>any</u> competitive airplane or engine manufacturer today. The Boeing Company has reported "deliveries to non-U.S. airlines have represented 55% of the total to date and will represent almost 60% of the total over the next 10 years" (2:5). Boeing is also forecasting a higher rate of growth for foreign passenger traffic than for U.S. passenger traffic during the next decade.

In a 1982 study, the Boeing Commercial Airplane Company explained the international competitive marketing situation as follows:

The political leverage and sales financing subsidies provided by the Europeans in support of Airbus Industrie play a strategic role in sales. Such support is critical in initial-order campaigns because of the long-term implications. When an airline has a choice between two similar models to meet a fleet requirement, the airline generally standardizes on its initial aircraft choice. Experience demonstrates that for every airplane in an initial order, more than three follow-on airplanes are ultimately sold. Therefore, it is critical to win initial key sales to gain entry into a carrier's fleet and thereby ensure follow-on orders. Although European programs have been economic failures

by U.S. industry standards (as demonstrated later in this report), there can be little question of the success of its marketing strategy. Airbus Industrie has received orders from more than 42 airlines in over 35 countries throughout the world, thereby capturing approximately 20% of the world market for commercial jet transports. Of particular concern is the recent acceleration of this market penetration. The erosion of U.S. market position in international (non U.S.) markets is even more dramatic.

The European sales strategy could be successful through the remainder of this decade. Industry sales of $126 billion (1982 dollars) are projected for the next 10 years, of which an estimated $75 billion or about 60% will be to non-U.S. airlines. These airlines are largely government-owned or controlled and are often susceptible to the political pressures and subsidized financing arrangements that characterize European sales strategy. This is evidenced by the overwhelming majority of Airbus Industrie sales to date that have been to government-owned airlines (about two-thirds of all orders) and almost half have been to European airlines. By way of contrast, only 13% of all orders for Boeing's latest models, the 767 and 757, have been to government-owned airlines. These are the Boeing models most directly in competition with Airbus Industrie. (2:8-9)

It is important to emphasize that local content, or even a locally based international cooperative partner, cannot guarantee an airplane manufacturer penetration of a protected or politicized market. Boeing's failure to penetrate the Italian market, even though Aeritalia is a major risk-sharing participant in the 767 program, has been a disappointment to Boeing Company officials. Recent Italian airline orders for new airplanes have gone to Airbus instead. A recent British Airways decision to purchase Boeing airplanes was not well received by Airbus or by some British politicians. British Aerospace, supported with government funding, is a partner in Airbus Industrie.

Cases like these, however, seem to be more the exception than the rule.

A U.S. Department of Commerce study stated that international cooperative agreements "provide the U.S. producers with enhanced access to foreign markets, particularly in the cooperating countries" (15:79). Boeing airplane sales throughout the Pacific area in general, and the Japanese market in particular, have been a bright spot for the company. In addition to easing access to foreign markets, international cooperation tends to decrease the number of potential competitors for a market.

Reduced Competition. As previously stated, large commercial passenger airplanes are not a mass-market type item. Unit sales are generally measured in the hundreds. The world market sales potential for any given airplane in a particular size category is usually only large enough to support two, or possibly three competing airplanes at the most. In the case of a jumbo-sized airplane capable of carrying 400 to 500 passengers such as the Boeing 747, the market potential is probably too small to support a competitor. The term "support" as used here refers to the likelihood that a manufacturer could sell enough units to reach a "break-even" point during a program. If there are too many competitors in a particular size category, the possibility exists that none of the competitors will break even.

> Reducing the number of competitive planes or engines is another purpose of multinational collaboration. There are few competitors in the large commercial aircraft and engine industries, but there are more companies than there are commercially feasible competitive products of a given size category. Joining actual or potential competitors may be preferable to competing in a market too small for all to survive. Given US antitrust restrictions on cooperation, American companies see themselves limited to working with foreign enterprises.
>
> Linkages among the three major engine manufacturers seem in part to be motivated by a desire to limit competition. The V2500 project joined the potentially rivalrous consortia led by Pratt & Whitney and Rolls Royce into a venture including partners from five countries. The General Electric collaboration with Rolls Royce discouraged each company from introducing a competitive product.
>
> Multinational ventures may also be used to discourage potential competitors from launching independent programs, or to weaken competitive alliances. Boeing's links with Japan and Italy may be interpreted in this light. Both partners considered alternative partnerships, and Japan may have been tempted to launch an independent effort. Bringing newcomers into consortia is a way of controlling these emerging competitors. (16:58)

The extremely high initial investment required, plus the lengthy time period anticipated before a program breaks even or yields a profit, makes any potential for decreased competition very attractive to airplane and engine manufacturers. International cooperation, in addition to reducing competition, provides further economic incentives, in the form of complementary resources and comparative advantage, to the cooperating companies.

Rationalizing Resources. Moxon and Geringer explained the phenomenon of resource rationalization by international cooperative partners as follows:

> Launching a new aircraft or engine program requires an engineering, manufacturing, and service infrastructure which takes years to develop, and which only a few companies possess. Cyclical sales make it difficult to keep facilities operating at capacity and encourage the extensive use of subcontracting. Especially in the construction of large airframes, it has been common for the manufacturer to subcontract major structures and subassemblies to the other companies. Multinational joint ventures represent a step beyond an already existing pattern of collaboration among companies. The subcontractor [partner] becomes committed to the project for a longer period, and shares more of the risk, in return for a larger potential profit and not being involved in a competitive bidding situation. This relationship is clearest in the Boeing 767 project, but the Airbus and International Aero Engines ventures also involve small partners whose role resembles that of subcontractors.
>
> Multinational partnerships usually make it possible to reduce investment by using existing capabilities. In the Airbus venture, none of the partners had the capacity to manufacture large commercial transports at an economically viable rate of production. Each of the partners also had a comparative advantage in producing certain parts of the plane--for example, British Aerospace had the necessary wing manufacturing capacity not possessed by the others. The partners combined their capabilities, each producing major structures and then using a complex logistical system to bring everything together at the assembly site. (16:57)

McDonnell Douglas' Mr. Favier was even more succinct on this subject. In reference to JADC's teaming with Boeing he said:

> The U.S. has a tremendous military procurement infrastructure that creates the underlying technology. The Japanese would have to spend phenomenal amounts of money on defense to create that. (21:38)

Advantages Versus Disadvantages

Farr, in his study of international cooperation on military programs, listed a number of potential advantages

and disadvantages to cooperation. The items he listed are essentially many of the same advantages and disadvantages found in the literature dealing with international cooperation on commercial ventures.

The potential advantages of international cooperative projects listed were (10:38-40):

1. A sharing of costs and risks.

2. A sharing of technology plus manufacturing and marketing skills.

3. An opportunity to expedite technological development.

4. The creation of jobs.

5. An improved industrial infrastructure.

6. An economic alliance which could become a foundation for future cooperation.

7. An improved balance of payments position.

In essence,

> More managers are seeing this pooling of technology, production capabilities and know-how, marketing skills, capital and managerial expertise as a synergistic and less risky approach to product innovation. (10:13)

The potential disadvantages listed were (10:42):

1. One-sided exchange of technology and skills.

2. Unacceptable cost growth due to inefficient subcontractors and complex organizational structures.

3. Management difficulties due to "fundamentally different management styles, budget processes and government policy."

4. The creation and strengthening of a future competitor.

5. Complicated decision making or even bad business decisions because of commitment to foreign partners and/or political pressures.

Mr. Thomas J. Bacher, Director of International Business for the Boeing Commercial Airplane Company, summed up the general situation in a speech delivered to the Society of Japanese Aerospace Companies:

> In considering international collaboration, the U.S. aircraft prime manufacturers weigh potential advantages against the disadvantages.
>
> Potential advantages such as improved market access, expanded export sales, financing support, risk/investment sharing and profit rate enhancement are compared to the eventual disadvantages of increased management complexity, reduced decision flexibility, reduced share of total program profit, and assistance to potential future competitors. (21:38)

Given that risk reduction, improved market access, reduced competition and resource rationalization may provide strong motives for companies to join in international cooperation in spite of the possible disadvantages, the next section discusses the trends expected for international programs in the commercial airplane industry.

Expected Industry Trends

The next airliner currently scheduled for market introduction is the Airbus Industrie A320. The European consortium plans to "roll out" the first A320 in 1988. Boeing and JADC plan to "roll out" the 7J7, a competing design in the same size category as the A320, by 1992. McDonnell Douglas may introduce yet another derivative of the MD-80 series, powered by propfan engines, to compete in the same market as the A320 and the 7J7. McDonnell Douglas has been negotiating with foreign manufacturers, apparently seeking a partner for the program.

Most of the current literature dealing with international cooperation in the commercial airplane and engine industry suggests that the recent trend toward "internationalization" will continue. Many of the same basic economic factors (costs, risks, market potential, etc.), which fostered international collaboration in the first place, are expected to prevail in the foreseeable future as well.

A U.S. Department of Commerce study of the civil aircraft industry has stated:

> . . . trends in the growing costs and risks of large transport development and production and in the marketing of large transports to foreign government owned or controlled/influenced airlines have resulted in increasing joint venture and international consortium business arrangements to spread the risk and aid in marketing to member countries. (15:80)

. . . it is likely that the present trend toward risk sharing and "internationalization" in the industry will continue and intensify. By "internationalization" we mean the forming of consortia of firms from different countries as partners, subcontractors, or suppliers to fund and carry out the development and manufacture of a large transport model line.

There are two complementary motives behind this trend: risk sharing and marketing. Individual companies, no matter how large and resourceful, may no longer be able to afford to take the entire risk of running up high development costs, given market and technical uncertainties. This motivating force can only become stronger for the development of next generation models in the 1990s. Governments which desire to establish and build their indigenous aerospace industries will, as noted earlier, be more likely to favor the purchase of an aircraft in which a national enterprise has had a piece of the action. The technical ability to manage an operation of this kind (and successfully assemble an aircraft under these conditions) has been and will continue to be greatly enhanced by advances in telecommunications and CAD-CAM technologies. (15:111)

Moxon and Geringer further highlighted the future importance of foreign markets:

A leading firm, such as Boeing in aircraft or Pratt & Whitney in engines, seems in less need of joint ventures than its smaller competitors, but it still must consider the potential advantages of such ventures. Reaching export markets is mandatory for success, as foreign markets are larger in aggregate than the US and are growing more rapidly. Even the largest companies are hard-pressed to find the resources for development, manufacturing and export financing of their own, and foreign partners can help. (16:58)

With regard to future concerns about technology transfer, the Department of Commerce study stated:

Possibly the technology transfer issue will recede somewhat in the future as the trend in international cooperation in large transport development and production continues. There is little likelihood that leading companies (whether U.S. or foreign) will "give away the store" or pass on the latest critical technology of future advantage to potential competitors under

> international cooperative coproduction or codevelopment agreements. As far as national defense and security questions are concerned, all the evidence suggests that U.S. industry has exercised great restraint in the transfer of development or production technologies of significance in these areas.
>
> Finally, one other point needs to be made. Technology transfer through cooperative international arrangements is a two-way street. Much of what is now important in advanced aerospace technology was not invented in the United States. One can reasonably argue that none of the major parties involved in future collaborative development efforts will be able to afford a posture that would stop such technical communication or try to constrain it in one direction. (15:80)

During the 7J7 program for example, Boeing is planning to use a proprietary rights agreement to "prevent our technology from flowing through them [7J7 program associates] to our competitors, or the competitors' technology being transferred to us." In addition, 7J7 program associates "must agree to invest at least as much in the Boeing project as they do in any potential competitor's effort" (6:33).

The Department of Commerce study also pointed out potential problems for the U.S. aircraft and engine manufacturers in this "internationalized" industry:

> The one qualification that must be mentioned in this generally positive assessment is the ability of U.S. manufacturers to adjust to the international operating conditions as described in this scenario. U.S. manufacturers are used to operating with subcontractors and junior partners. It remains to be seen if they will be willing or able to operate cooperatively with major partners. In present international ventures, U.S. manufacturers have remained the dominant partner, with management and technical control. The U.S. firm retains ultimate decision authority and technology transfer can be limited to need to

know. This kind of arrangement has kept U.S. management comfortable, but under the international consortia scenario postulated for the development and manufacture of next generation aircraft, U.S. manufacturers are unlikely to retain such a dominant and controlling position. Management decisions will be reached by coalition building within the consortium or by consensus--a much more politically oriented and time-consuming process and one, perhaps, ill-suited to current U.S. industry management style. (15:112-113)

A political, time-consuming management process is frequently cited as a major problem within the Airbus Industrie consortium. But an even more threatening trend was noted by the Department of Commerce study:

> . . . the provision of state subsidized or state supplied development capital by European governments, or the well-known targeting policies of the Japanese government, may seriously threaten the competitiveness of U.S. industry. Determined and concentrated efforts by governments in launching a new or next generation large transport could effectively gain them a competitive lead. (15:114)

In a 1982 study, the Boeing Commercial Airplane Company also noted this trend toward foreign government subsidization of its aircraft industry. "The result has been an abrupt shift from a generally free market competitive environment to one in which U.S. private capitalism is pitted against European state capitalism" (2:2).

According to the Boeing study, "European governments . . . have introduced government funding support and subsidies at unprecedented levels, as well as the element of 'political leverage' or influence" (2:6). Boeing estimated the subsidy "equals a per-airplane subsidy of $7 to $8 million, or 20% to 25% of airplane price." The

conclusions drawn in this Boeing study suggest that there is "no possible prospect of breakeven for the Airbus programs" (7:12).

> . . . A300 production would have been abandoned some time ago under U.S. private industry economic criteria. However, manufacturing subsidies allowed the program to survive, and government marketing assistance (sales financing subsidies and political leverage) has provided the market penetration required to sustain the program in the future. (2:12)

With regard to the world's airline industry, a recent trend toward "commonality" is frequently cited in the research literature:

> "Commonality" is an airline industry buzz word--if you get all your aircraft from one manufacturer you save money because they share spare parts, maintenance procedures and cockpit-crew training. (3:34)

For the aircraft manufacturers, this implies a competitive edge in the market can be gained by offering an entire "family of aircraft," rather than only being able to offer one or two models. The "family of aircraft" concept refers to the development of several aircraft with a broad range of seating capacities, configurations, operating characteristics and distance capabilities. This enables the airlines to purchase the airplanes best suited to their particular route structure and market segment. Airbus Industrie is developmeng a "family of aircraft"; Boeing already has one.

"Commonality" and the "family of aircraft" concepts also tend to suggest that international cooperation

will continue in the future. If they plan to survive in the long run, competitors in the commercial airplane industry may need to accept the costs and risks of developing not just one airplane, but a whole family of airplanes.

With regard to future Boeing participation in international cooperation, Mr. Bacher has stated:

> Joint programming possibilities are continually being explored with other countries that have the capabilities to participate.
>
> Every industrial country that has an aerospace industry, one way or another, has had discussions with us--and with our competitors. Everybody talks to everybody.
>
> International involvement in the Boeing program has increased significantly during recent years, and continuation of this trend is planned for the future. Boeing intends to be in the forefront concerning business concepts adapted to the changing international environment. (21:38)

The Boeing 767 Program

When the Boeing Commercial Airplane Company signed agreements in 1978 with Aeritalia (Italy) and the Japan Aircraft Development Corporation (JADC), it marked the first time a foreign airframe company became a risk-sharing partner in developing a new U.S. commercial jet transport. Aeritalia and JADC each were responsible for approximately 15 percent of the development costs and total dollar volume of the project, excluding the engines. Boeing's predominant motives were a desire for risk-sharing and a hope for increased market penetration (1:24).

Moxon and Geringer summarized the general workings of the 767 partnership this way:

> The Boeing 767 project is characterized as risk-sharing subcontracting. The junior partners are guaranteed a certain share of the work in return for participating in the development costs. They receive a given price per unit, but their profitability, like Boeing's, depends on the number of planes sold. (16:55)

> With the risk sharing partnership, such as the Boeing 767 project, the role of the smaller partner is expanded frequently to include detailed design work and assumption of a share of development costs proportional to its share of manufacturing work. As in subcontracting, the prime contractor in a risk-sharing venture seldom relinquishes control over the initial design work that establishes project boundaries. Generally, the contractor also retains control of marketing, receives all sales revenues, and pays a given price per unit to the risk-sharing partner. (16:60)

From JADC's perspective, the "stringent economic and manufacturing demands of the Boeing 767 program" required "a substantial increase in efficiency," "a major expansion of production capability" and "advances in manufacturing technology." The terms of the agreement were seen as "severe" because Boeing demanded a "very tight" schedule and insisted on dealing strictly in U.S. dollars. Noboru Hatakeyama, the director of the Ministry of International Trade and Industry (MITI), Aircraft and Ordinance Division, believed, in spite of the problems,

> This program might become the special impetus for modernization of the Japanese aircraft industry, by trying to catch up with Boeing, which is the most efficient and productive aircraft company in the world [sic]. (19:31)

Noting this Japanese government goal for its aircraft industry, Moxon and Geringer stated:

> A related concern is how well a proposed program uses a firm's capabilities or enhances those capabilities. Some projects fit better with one partner's long range goals than with the other's. For instance, the Japanese government has an expressed goal of developing domestic capabilities in all aspects of airframe and engine development and manufacturing. The Ministry of International Trade and Industry, therefore, has made access to government-funded subsidies for joint ventures contingent on participation by Japanese firms in manufacturing technologies for which it wants to improve domestic capability. (16:59)

The Japanese government loaned JADC approximately 50 percent of the development costs for the 767 program, and JADC has repaid approximately 25 percent of the loan to date. Prior to the 767 agreement, Japan's attempt to build its own large commercial transport aircraft, the Nihon YS-11, had financially failed (19:32).

From Boeing's perspective, according to Mr. Bacher, Boeing's experience with international cooperation on the 767 program has been positive. "As for the work accomplished, our view is that it has been very satisfactory in terms of quality, schedule, and contracting arrangement" (14:212). According to other Boeing officials,"Hardware that meets Boeing specifications has been received on time from each nation" (13:225).

Moxon and Geringer addressed several potential problems which had to be overcome during the 767 program:

> This leads to the issue of overall project responsibility and decision-making. Multi-party consortia can be plagued by cumbersome decision processes, especially if governments are involved. When management systems differ between firms, decisions may be complicated or slow, a potentially fatal weakness in

> a dynamic industry like aircraft. There is, however, a strong argument for one partner to assume leadership of the venture, and this is usually the desire of the larger partner. But smaller partners, while appreciating the need for prompt decisions, are skeptical that their interests will be considered and may suspect that a preference for clear authority disguises an unwillingness to share vital aspects of the business. Boeing, for example, has had difficulties in negotiating agreements with others due to its insistence on overall project authority. Negotiations on proposed collaboration with British Aerospace on the 757 collapsed partially because of Boeing's demands for control, and discussions with the Japanese for the 767 transport bogged down repeatedly for the same reasons. (16:60)

> In ventures like the Boeing 767 and V2500, careful limits have been placed on technology transfer and on the decision-making authority of junior partners. On the 767, Boeing was clearly in charge. (16:61)

"International collaboration has potential pitfalls, and Boeing has a firm set of rules to avoid them" (13:225). Mr. Bacher made the following statements about Boeing's "rules" (13:225-227):

On Boeing's program leadership --

> We don't know how to design, develop and produce an aircraft as a committee. It is the inherent nature of the business that the tremendous amount of innovation required demands a certain amount of central leadership, or the integrity and efficiency of the program will be penalized.

On inefficiencies due to conflicting philosophies--

> We do not want to do anything that complicates the decision-making efficiency or the design, development and manufacturing efficiency of a program just to accommodate our international partners. A large part of our market is the U.S. airlines, and we don't want to penalize U.S. customers for foreign sources, and we never do.

On a phased approach to international cooperative agreements--

> Just like we have a phased approach in our technical and program activities, we feel it is reasonable that a phased approach be used in our joint program discussions. It would not make sense for us to write a firm contract on a business arrangement when we are not equally sure of our aircraft configuration or market timing or engine availability.

On offset agreements to place a certain share of work in a specific country--

> Fundamentally, the Boeing Company is against offsets--we try to avoid them. But we are a market-oriented organization, and we will do almost anything to make a sale.

In the research literature available to date, very little has been written concerning how these "rules" were put into action during the Boeing 767 program, or any other commercial aircraft project for that matter. Specific information detailing program management structure, techniques and practices, which appear to contribute to success or failure in various program areas, is sorely lacking.

One of these rare articles discussing "specifics" was devoted to the dedicated telecommunications system purchased for the 767 program. The expense of the $1 million system and its operating costs were shared by Boeing, JADC and Aeritalia.

Mr. Dean Thornton was Boeing's Vice-President in Charge of the 767 Division at the time; Mr. Thornton has since become the President of the Boeing Commercial

Airplane Company. Mr. Thornton "realized an efficient communications system between the various units working on the project was essential." "Rapid, if not immediate transmission between the various sites" was necessary to enable all the participating companies to work "from a common data base" (7:16). Mr. Thornton summarized the problem which this communications system was intended to solve:

> The further away you get, the bigger your control problem. When you throw an ocean in the middle, and add language and cultural differences, it makes it very difficult to keep to schedule and control the configuration design.
> After all, there are over 90,000 parts in an aircraft. Maintaining control over them all is difficult enough when we are dealing with our own plant only 50 miles away. (7:16)

The communications system included capabilities for voice, data, teletype and fascimile transmission. According to Mr. Fred Cerf, Boeing's Director of Program Participants, "design changes made there had to be incorporated in the designs here" otherwise the "cost of a wrong or confused decision in these circumstances would have been phenomenal" (7:17).

In further summarizing the functions of this communications system, the article stated:

> "We also managed the logistics and support systems for functions such as shipping over the communications system," adds Cerf. "We have to ship the entire rudders and fins. A simple matter like setting up the shipping plan can be a very complicated document, pages long." Using identical charts in both communications centres,

precise agreement was obtained on each stage of the shipping process, and progress monitored from both ends.

Language and cultural communications problems were partly eased by the presence of 30 Boeing engineers in each of the partner countries. These engineers helped interpret instructions from Seattle, and were sent copies of all communications in either direction so that they could intervene where necessary. Those Japanese engineers whose spoken English was poor usually had a good grasp of written English. The facsimile facility of the communications system allowed them to carry on conversations with their counterparts in Seattle, by scribbling notes in longhand, says Eiji Shinomiya, a spokesman for the Japanese Civil Transport Development Corp.

The Boeing engineers on the partners' premises had another function besides smoothing communications. They were expected to keep Seattle informed of any deviations or potential deviations from the carefully planned schedule of design and construction, on a daily basis. Once a week there would also be a co-ordination meeting, over the communications system, between the on-site engineers and the project managers in Seattle.

In its overall evaluation of the communication system's effectiveness Boeing lays considerable stress on savings in travel costs. Cerf also believes that "the job probably couldn't have been done on schedule without it." (7:17-18)

The focus of the personal interviews conducted for this research study was to gather more of this type of specific information. But an important ingredient in developing a knowledgeable background for these interviews was a review of several prior studies on international cooperation.

Prior Studies

Based on his case-study analyses, Farr's conclusions and recommendations included the following management principles (10:170-180):

1. A high level forum, such as a steering committee, should be used to resolve issues and provide strategic guidance.

2. The international partners of a cooperative project should grant a high level of authority to a single manager, who directs an internationally staffed, co-located project team.

3. For relatively small programs, extra effort should be expended to insure that adequate support for the program exists.

4. The goals and objectives of each international participant must be clearly identified, and formal mechanisms structured at the outset so that these various goals can be achieved.

5. Technological advance should be attempted in an evolutionary, incremental fashion.

6. Extra care should be taken to structure a program in which benefits are equitably distributed and in which all participants are "equally happy or unhappy" with the results.

7. Government and industry members of the project team should be carefully chosen to maximize experience along the following dimensions: managerial experience, international experience, and experience with the relevant technology.

8. There should be active planning for and anticipation of various environmental/external influences such as inflation; unplanned cost, schedule, and production volume changes; increased threat of war; etc.

Additionally, "under the sponsorship of the F-16 System Program Director" a study by Peat, Marwick, Mitchell and Company synthesized the lessons learned from the F-16 coproduction program. The following are included among the lessons learned:

> [1] Common or supportive objectives and mutual understanding are key requirements for forming a consortium. (20:III.3)
>
> [2] Program cost responsibilities and cash flow forecasts are necessary elements to understand each consortium member's financial responsibility. (20: III.11)

[3] A steering committee is a useful organization to articulate and resolve policy issues in a multinational program. (20:III.12)

[4] The management agent responsible for fulfilling commitments under the memorandum of understanding should have authority equal to his responsibility and accountability. (20:III.14)

[5] Decentralized authority and low level organizational alignment can cause delayed management decisions because of necessary coordination efforts of the system program director. (20:III.14)

[6] Flexibility and a desire to work cooperatively will be necessary to avoid conflicts. (20:IV.7)

[7] Economic risk--inflation and currency rate fluctuation--threaten program stability. (20:IV.15)

[8] Regardless of the spirit of partnership which genuinely exists among those who work together to establish a multinational program, there are a multitude of individuals and organizations who are not party to the partnership and who simply play by other rules. (20:IV.19-20)

[9] Coproducers are different companies with different goals and objectives. They will choose to participate in a coproduction program based on their assessment of the program's benefits to them. (20: IV.29)

[10] The focal point concept in conjunction with good working level communications is an effective means of facilitating coproduction. [Refers to establishing a communications focal point.] (20:IV.33)

[11] Transfer of high technology generally results in . . . [high costs to the company initially possessing the technology]. This results in an economic disincentive to transfer high technology work to coproducers. [This] should be recognized and planned early in the program. (20:IV.42)

[12] Industry . . . approached the F-16 coproduction program from a pragmatic, product centered position. Use of proven project management techniques and attention to detail are cited as key success factors. (20:IV.46)

> [13] [U.S. industry] is cognizant of economic and political impetus to collaborate with non-U.S. companies if they are to sell products abroad. Their approach is pragmatic, flexible and company based. (20:IV.52)
>
> [14] [U.S. industry] wants to retain its perceived edge in development/design and systems engineering/ integration. [U.S. industry] generally prefers coproduction to codevelopment. (20:IV.52)

Several key factors to understanding international cooperation were cited in two reports by the Defense Science Board Task Force. The first report discussed cooperation with Europe and listed among its findings:

1. Jobs are a prime consideration with European governments (17:15).

2. European governments desire their own national defense industry. Industry is protected as a national asset (17:15).

3. Because of lesser defense expenditures by European governments (compared to U.S.) foreign defense industries "must export to be viable" (17:15).

4. Large disparity in research and development funding (U.S. vs. Europe) makes codevelopment difficult. The technology sharing has been perceived largely as one-way, with U.S. industry, getting little in return, concerned about building competition (17:18).

5. Europeans prefer codevelopment. Industrialists are critical of some coproduction because they cause investment to create a large industrial capacity--with no follow-on production (17:19).

The second report by the task force covered industrial cooperation with Japan. Included in the findings:

1. The Ministry of International Trade and Industry (MITI) and the Ministry of Finance have a pervasive role in the selection of national priorities, in guiding industrial development and in arranging consortia and financing for large projects. Under the guidance of MITI, Japan's Gross National Product has grown from 8 percent of U.S. GNP in 1960 to almost 50 percent that of the U.S. in 1983 (18:23).

> [2] Japan has created [a] "technological momentum" which will increase their current lead over U.S. industry in some fields and will enable success in their long term national commitment to technology innovation. [This is because of resources dedicated to research and development.] (18:17)

3. It is "vital to U.S. interests" to broaden defense and economic cooperation with Japan--the "strategic value of closer technology cooperation . . . outweighs [the] drawbacks of [eventual] competition" (18:65).

4. Broader technology cooperation should be undertaken on an industry-to-industry basis conditioned on a reciprocally "beneficial two-way flow of technology" (18:65).

5. There are many potential fields of cooperation. Among the primary U.S. technologies of interest to Japan: aircraft and jet engine technologies (18:43).

[6] Japan's defense industry will continue to grow, with or without U.S. technology cooperation. U.S. partnership would help retain U.S. participation and influence. . . . (18:50)

[7] [The] U.S. base of technological innovation is [a] vital national asset, fundamental to our military security and economic well-being. We cannot maintain our lead by conservation and protection alone--we must run faster. (18:77)

Finally, a U.S. Department of Commerce study entitled A Competitive Assessment of the U.S. Civil Aircraft Industry stated:

[1] . . . commercial aircraft producers and engine manufacturers have undertaken to decrease the financial risks of new commercial aircraft development by involving one or more foreign "partners" in the program. These cooperative arrangements inevitably involve a certain amount of technology transfer. On the other hand, these arrangements provide the U.S. producers with enhanced access to foreign markets, particularly in the cooperating countries. (15:79)

[2] The key variables in the present economics of large transport development and production are the unit price that the aircraft assembler can charge for the aircraft, the cost of capital, and the number of units that can be produced and sold over the life of the project. (15:49)

[3] Over much of the size range for large transports it appears that the world market does not offer sufficient unit volume for three producers to realize a satisfactory rate of return. At the upper end of the size range (500 seat) probably only one producer can be profitable on a purely commercial basis. Under these conditions the U.S. producers are likely to become increasingly reluctant to launch new models. (15:59)

[4] An unsuccessful project or even a marginal project can impair the ability of a private firm to make major investments for new models for a number of years. This was certainly the case with the Lockheed L-1011. (15:59)

[5] If Airbus is willing to launch a 150-seater because it is not constrained by the rate of return that U.S. producers use in capital allocation decisions, then its ability to compete is increased significantly. (15:59)

[6] Airbus is not as dependent as U.S. manufacturers on a large commitment of orders for a launch decision. It can count on direct financial support from member governments as well as being able to obtain substantial orders from the national airlines of the consortium countries. (15:69)

[7] The apparent lack of unanimity among Airbus partners on a decision to launch the A-320 underscores the basic vulnerability the consortium faces: the difficulty in making timely and cost-effective decisions in an environment of different national interests and tightening national budgets. (15:70)

[8] A key strength of the U.S. civil aircraft industry is its recognized ability to respond quickly and strongly to a constantly changing environment of market signals and technological opportunities--more quickly and strongly than can the multinational Airbus or could a new national entry from Japan, which would have to build up advanced design, development, manufacturing, and worldwide service/maintenance operations. The one strength of the U.S. industry that observers continually come back to is its management--a feature of an industry that cannot be guaranteed by targeting or subsidies. U.S. civil aircraft management has learned to adjust quickly to economic cycles, continues to invest heavily in R&D technology applications, is willing and able to compete internationally and has had experience in taking risks and succeeding. (15:112)

[9] Thus far, Japanese firms have participated as major risk-sharing subcontractors on major aircraft projects only with Boeing and Aeritalia on airframe parts for the 767 and with Rolls-Royce for the development of a new jet engine. These contracts, coupled with U.S. licensed production of military aircraft (such as the F-15 and P-3) have enhanced Japan's technological base and its commercial aircraft capability. (15:73)

[10] Given the strong commitment of the Japanese government to the development of an aircraft industry and the past record of accomplishment of many Japanese

industries, this industry will likely continue to develop and broaden its capability in the years ahead. (15:73-74)

[11] [With regard to technology transfer] Management techniques are less likely to be transferred effectively and it is in this area that U.S. firms may find their greatest competitive strength over the long run. (15:80)

Research Hypotheses

The information reported in this literature review regarding the Boeing 767 program, and the results of the five previous studies cited, suggest that Farr's hypotheses dealing with program management structure, technology factors and contextual environment will provide a sound framework for this research effort. The approach of this study will be to replicate Farr's Ph.D. research, and the research hypotheses will be those developed by Farr in his literature review (10:70-71).

I. PROGRAM MANAGEMENT STRUCTURE:

H1: International cooperative programs guided by steering groups are more likely to be successful than programs guided by parent bureaucracies or other ad hoc organizations.

H2: International cooperative programs in which program managers are granted high levels of authority are more likely to be successful than programs in which program manager authority is more limited.

H3: International cooperative programs of larger size are more likely to be successful than projects of smaller size.

H4: Programs in which participants' requirements and goals are carefully harmonized at the outset will more likely be successful than those in which requirements/goals are not harmonized.

II. TECHNOLOGY RELATED FACTORS:

H5: International cooperative programs which attempt few and modest advances to the state-of-the-art are more likely to be successful than programs which attempt multiple and major advances.

H6: International cooperative programs in which each partner's share of technological benefits is perceived as being in proportion to its contribution are more likely to be successful than programs in which shares are not so perceived.

H7: Programs in which participants have relatively more experience with international programs and with the relevant technology will more likely be successful than those in which participants have less experience.

III. CONTEXTUAL ENVIRONMENT:

H8: International programs whose program managers and team members are more program oriented than parent [company] oriented are more likely to be successful.

H9: Programs in which there is less environmental uncertainty will more likely be successful than programs which experience more uncertainty.

H10: Programs which are structured to minimize uniquely international concerns such as geographical separation, cultural differences, language barriers, etc. will more likely be successful than programs that do not minimize such concerns.

III. Methodology

Chapter Overview

This chapter explains the research methodology employed to gather information for the findings which are presented in Chapter IV. The research method is explained first, followed by a justification for this particular approach to the research. The chapter concludes with an explanation of the decision criteria used to evaluate the research hypotheses.

Research Method

The basic research design selected for this study was a case-study analysis. Personal (face-to-face) interviews were used as the primary method to gather the data. The information gathered using this particular survey method was ex post facto. When possible, secondary sources were used to verify the interviewees' responses.

The survey instrument used during the personal interviews was an interview guide which is attached as an appendix to this report. This interview guide was originally developed by Farr for his case-study analyses. For the purposes of the current research study, Farr's interview guide was slightly modified so as to be applicable to a commercial venture in general. A very few questions were modified to apply to the Boeing 767 program in

particular. These modifications however, did not change the essence of Farr's original questions.

The interviewees were selected using judgement (purposive) sampling. The primary criteria employed in selecting the sample was significant personal experience in program management or engineering management duties on the Boeing 767 program.

Justification

Very little has been written about the "specifics" of how international cooperative programs have been managed. Knowing these specifics is essential to any proper evaluation of the research hypotheses, and an investigation with a significant degree of detail is required to uncover these specifics. A case-study approach emphasizes "the detailed analysis of a limited number of events or conditions and their interrelationships." Furthermore, program management is certainly an interactive process and "case-study analysis is concerned more with interactive processes" (8:61).

Farr stated that "existing knowledge is insufficient for the development of comprehensive survey questionnaires that could subsequently be analyzed with various statistical methods" (10:72). He felt that "case analysis was ideally suited" to this type of investigation because it provides (10:72-73):

[1] . . . sufficient depth to begin to accumulate an organized body of knowledge

[2] . . . a greater sense of direction . . . than the purely open ended, unstructured approach to exploratory study

[3] . . . the ability to investigate issues in which some information is known, but which are still not well understood

[4] . . . the ability to probe complex and subjective issues that is not possible with the use of survey documents

[5] . . . the necessary bridge to move from exploratory work to the effective use of surveys and statistical modeling

The personal interview was selected as the most appropriate survey technique because the researcher believed that both the quality and depth of the information gathered would be enhanced. According to Emory, "the greatest value [of personal interviewing] lies in the depth and detail of information that can be secured" (8:160). In addition, the personal interview allows the researcher the opportunity to clarify questions as well as responses. Finally, the lengthiness of some of the answers required, and the length of the interview guide in total made it highly unlikely that telephone or mail surveys would produce the depth of information required. Emory has suggested that telephone or mail surveys should be able to be completed in ten minutes or less (8:171-172). The interview guide used requires sixty to ninety minutes as an approximate average.

Since this study was a replication of Farr's previous research, a slightly modified version of Farr's

interview guide was used. The interview guide was designed to secure data relevant to evaluating the research hypotheses. As in Farr's study, judgement (purposive) sampling was used. Emory has stated that during exploratory research like this, "a judgement sample is quite appropriate" (8:280). This method ensured that the respondents had the necessary experience with an international cooperative program to be able to answer the questions posed by the interview guide. As a replication, both the interview guide and the sampling method were important factors in providing consistency with the original study. The research findings of the current study can thus be considered as adding to the data base begun by Farr.

Decision Rules

As in Farr's research, success was defined as: (1) the ability to meet or exceed stated cost, schedule, technical and offset performance goals; (2) the non-withdrawal of any partner(s); and (3) perceived success as expressed by key people knowledgeable about the project. While some of the factors may seem to be very apparent on a particular program, other factors may not be so easy to classify as successful or unsuccessful. As Farr explained:

> By its nature, case analysis requires the researcher to somehow combine subjective interpretations and multiple viewpoints into a coherent, and hopefully accurate representation of program events. (10:97,100)

In the current study, a classification of the program as successful or unsuccessful was made according to the researcher's best judgement, based on the stated definition and the research findings.

IV. Research Findings

Chapter Overview

This chapter presents the research findings from the personal interviews conducted at the Boeing Commercial Airplane Company during the week of June 23-27, 1986. The list of those interviewed for this research is included as an appendix to this report.

As a condition for being granted personal interviews with these Boeing personnel, the researcher agreed to nonattribution to a specific individual of any statement made. As a further condition, the researcher agreed that these findings would be subject to release only upon the approval of the Boeing Commercial Airplane Company.

This chapter begins by discussing the performance ratings for the 767 program given by the interviewees. The performance ratings were necessary to determine whether the program was successful or unsuccessful. This determination was essential prior to any evaluation of the research hypotheses.

The next section of this chapter presents an evaluation of the ten research hypotheses based on the interview findings. For each hypothesis, the hypothesis is restated for the reader's convenience, the researcher's conclusion pertaining to the hypothesis is stated, and

the conclusion is supported by a discussion of the interview findings related to the hypothesis. This section is followed by a brief explanation of findings derived from the open-ended comments portion of the interview guide.

The final section of this chapter discusses the interview findings which pertain to the Boeing 7J7 program. The research hypotheses are not evaluated for this program, and no conclusions are attempted since the 7J7 program is in a preliminary stage and program performance ratings cannot yet be determined.

Program Performance Ratings

All of the six interviewees who rated the 767 program rated the achievement of cost, schedule and technical performance goals as highly successful. One senior executive pointed out that the 767 was the first new Boeing airplane program to be completed "under cost and on time." He also stated that all technical performance goals were met or exceeded.

Another Boeing executive stated that in terms of the overall program, "we couldn't have done better at Everett" than the program participants did in their own factories. [Everett, Washington is the location of Boeing's 767 assembly plant.] He also stated that while the Japanese companies initially lacked some of the necessary technology and had fewer experienced engineers than

Boeing, "the Japanese made up for the difference with determination--they worked harder, they learned faster, and they worked longer hours."

It is the researcher's best judgement, given the opinions of those knowledgeable about the program's cost, schedule and technical performance goals, that the 767 program was "successful." Neither the researcher nor the interviewees were aware of any offset goals between Boeing and the foreign participants in the program. None of the companies involved in the program has withdrawn.

Hypothesis One Findings

> H1: International cooperative programs guided by steering groups are more likely to be successful than programs guided by parent bureaucracies or other ad hoc organizations.

Conclusion: H1 supported

The 767 program's major policies and decisions were guided by a steering group known as the Boeing Commercial Airplane Company (BCAC) Executive Council. The Executive Council meetings were held quarterly. The Executive Council also met as required at major decision points. The voting members of the Executive Council included the BCAC President, the BCAC Senior Vice-President and the Executive Vice-Presidents of BCAC. The non-voting members of this Executive Council included the Managing Directors of all the foreign companies which were classified as "program participants" rather than partners. These

program participants shared the risks and some of the technology, but unlike full equity partners, these companies did not have any voting representation on the Executive Council. Even though they did not have any voting power, the presence of the Managing Directors allowed the program participants to present their inputs to the Executive Council before major decisions were made.

In addition to policy guidance and decision making, another primary function of the Executive Council was to serve as a high-level focal point for communications between Boeing and the program participants. Since the Managing Directors of the foreign companies were in attendance when the BCAC Executive Council met, all the companies involved knew what decisions had been made, as well as why those decisions had been made.

The Boeing executives interviewed believed that this structure and method of operation of the Executive Council worked extremely well. Once the alternatives were examined and the decisions were explained, there was no apparent disagreement among the program participants. Everyone involved with the Executive Council meetings felt that the best possible decision had been made in terms of the overall program.

According to the interviewees, the steering group for the 767 program was composed of very high ranking executives with strong decision authority. The members of this

Executive Council were collocated for their meetings. These members were highly competent and they rendered very timely decisions. The Executive Council was considered to be a major reason for the success of the 767 program.

Hypothesis Two Findings

> H2: International cooperative programs in which program managers are granted high levels of authority are more likely to be successful than programs in which program manager authority is more limited.

Conclusion: H2 supported

The overall responsibility for program management of the day-to-day operations for the 767 program was vested in a single individual--the Vice President/General Manager, 767 Division. This executive was given complete authority to make daily operating decisions and to resolve operational conflicts if necessary. Interference or overturning of his decisions at a higher level occurred rarely, if at all.

As stated previously, the major policy guidelines and program decisions were made by the Executive Council. (Examples of a major policy guideline or decision include a change in the production rate in terms of aircraft per month, establishing standard cost figures to be met by program participants, or setting the aircraft pricing policy for the various airlines.) The Vice President/ General Manager was also required to make a recommendation to the Executive Council pertaining to such major

decisions. The Council's decisions usually followed this recommendation.

The interviewees overwhelmingly agreed that program management of the 767 program was strongly proactive. They felt that most aspects of the program had been thoroughly preplanned. They generally agreed that all the major problems possible had been both foreseen and planned for and, as a result, there were no major unpleasant surprises. One senior executive, with experience on several Boeing programs, remarked that the 767 program was easily "the smoothest" program he had ever seen.

This is not to say that there were never any problems or that management was never reacting to unforeseen difficulties. There were minor problems such as brief difficulties with a foreign labor union, and a lack of prior coordination for office and secretarial support in a foreign participant's plant. But once the managers involved explained what was needed, these small problems were generally quickly resolved. The interviewees generally agreed that there were no more problems during the 767 program than there had been with any new airplane program. Some interviewees felt that there were fewer problems than is typical of new programs.

It should be emphasized that although there were minor unforeseen problems and some crisis management in reacting to those problems, this was not the normal mode

of operation. The sense of the interviews was that the 767 program was very well defined and very thoroughly planned and, as a result, there were no major problems.

Hypothesis Three Findings

H3: International cooperative programs of larger size are more likely to be successful than programs of smaller size.

Conclusion: H3 supported

It was agreed prior to the interviews that no questions would be asked about specific dollar investments or specific costs. These questions were not necessary to determine the size of the 767 program. From the research literature previously cited, it could be adequately determined that this was a large, multi-billion dollar program.

The program director was a high ranking executive with a large staff in the United States and smaller program staffs in both Japan and Italy.

The Boeing Company as well as the program participants had large investments at stake in the 767 program. Careful planning, close supervision and close coordination between Boeing and the participant companies were used to control the program and to minimize the risk to each company's investment.

The 767 program was a large program and required a high dollar investment under conditions of some risk. The program received high-level management attention in all companies involved.

Hypothesis Four Findings

H4: Programs in which participants' requirements and goals are carefully harmonized at the outset will more likely be successful than those in which requirements/goals are not harmonized.

Conclusion: H4 supported

Each of the interviewees stated that all significant decisions regarding the joint requirements and objectives of the 767 program were made at the outset, and that none of these types of decisions was deferred. Several of these executives emphasized the need to be "up front" when dealing with the program participants.

BCAC approached the negotiating and contracting process with each program participant in increments. That is, several years of preliminary discussion and design work evolved into a Memorandum of Understanding (MOU). This MOU led to a series of preliminary contracts, and these were followed by a final contract.

This final contract included the cost, schedule and technical performance requirements and objectives for the 767 program as well as the revenue sharing objectives. There were no offsets required outside of the 767 program as a result of this contract.

The interviewees stated the foreign participants did not actually participate in specifying the cost, schedule or technical performance goals on the 767 program. Instead, Boeing developed and clearly defined the goals.

Once BCAC "proved" the goals to the participants' satisfaction, these goals were accepted by the foreign companies. (For example, Boeing defined what it would cost BCAC to design and produce a subassembly in its own plant. Boeing then "proved" or demonstrated how it could meet this cost goal to the participant planning to produce this subassembly. The participant then accepted this cost goal, and agreed to deliver the subassembly to Boeing at the same price as it would have cost Boeing to produce it.)

It is important to emphasize that although the program participants had very little, if any, actual effect in specifying the desired cost, schedule and technical performance goals, all of the foreign companies involved had ample opportunity to question Boeing's figures and to make their inputs known to Boeing before the final contract was agreed upon. Thus, even though the foreign companies did not directly participate in setting the goals, these goals were harmonized at the outset among all of the companies involved. Although Boeing was definitely in control of the 767 program, they carefully listened and fully understood the concerns of the program participants. However, Boeing was also very straightforward in explaining and demonstrating the cost, schedule and technical performance goals necessary to assuring the 767 airplane would be a market success. Through the lengthy process of incremental contracting, these goals were

slowly defined by Boeing, and accepted with satisfaction by the program participants.

This evolutionary approach to negotiating, coupled with BCAC's emphasis on being completely "up front" with the program participants, were felt to have contributed greatly to being able to specify the joint requirements and objectives at the outset of the program. Thus, no major decisions regarding joint objectives were deferred until later in the program. One senior executive stated that the early definition of program objectives resulted in minimizing surprises. The interviewees also stressed Boeing's strong orientation toward its market in developing the 767 program.

Robert G. Cooper, in his 1980 study entitled Project Newprod: What Makes a New Product a Winner, referred to a previous research effort by stating:

> The most important finding was that the great majority of these innovations (three quarters) were market derived, or market pull ventures, and only 21% were technology push. An existing demand or need was the most common single ingredient in comparing these successes. (8-9)

Another author attributed much of Boeing's success "in its 70-year history" to giving "the market what it wants, not what its engineers think it wants" (3:24).

All those interviewed felt that the 767 program originated because of a strongly perceived need for the product within the world's airline industry. In fact, at

least one airline was involved to the extent of providing some financing for joint development in the earlier stages of the 767 program.

The interviewees unanimously felt that requirements and objectives had been well harmonized at the outset, and that no serious interface or integration problems occurred throughout the entire program. They pointed out several problems which could have occurred, but stated that the major foreseeable problems had all been planned for, and thus were avoided entirely. (One example cited was a foreign company's lack of plant capacity at the outset. This company invested the necessary capital funds to expand to the required plant capacity before the program went into production. Because of this expansion, the program avoided production slowdowns due to plant capacity limitations.)

All of the interviewees stated that there was never any governmental political pressure applied to program office decisions. However, it was noted, foreign airlines are sometimes strongly pressured by their national governments when they are negotiating to buy new airplanes. As noted earlier in the literature review, this political pressure has apparently been felt by some potential 767 customers.

Hypothesis Five Findings

H5: International cooperative programs which attempt few and modest advances to the state-of-the-art are more likely to be successful than programs which attempt multiple and major advances.

Conclusion: H5 supported

The major technological advances incorporated in the Boeing 767 program included digital flight instrument systems, large parts including some control surfaces made of composite materials, aluminum alloy materials used in some structures, and a fuel efficient, high bypass turbofan engine. All of the interviewees felt that the technical advances made during this program were generally modest advances involving a small amount of technical risk. One interviewee felt that incorporating digital flight instruments was a modest advance but that it was also moderately risky at the time. Another executive stated that the structures were really not much different from prior Boeing airplanes, but rather a refinement of previous technology.

One interviewee explained that the greatest risk was not so much in whether or not something could be done. Instead, he stated the risk was primarily in whether or not you could prove (to the Federal Aviation Administration officials) that you have done it.

One major concern early in the program was the on-time delivery of certain large composite parts planned

to be built in Italy. The technology was fairly new to Aeritalia, so as a contingency plan, Boeing built some initial shipsets of these parts just in case the Italian participant's parts were delayed. As one executive explained, the Italian engineers were extremely good and the workers manufacturing the composites were "real artisans." Another executive rated Aeritalia's composite manufacturing and material as excellent. The composite parts arrived at the Boeing assembly plant on time, and the Boeing-built "backup" parts were never used in an airplane.

This composite technology along with the other technological advances previously listed were not all completely proven technologies, but neither were they the large "star wars" type of technological advances. The interviewees felt that these were modest advances to technologies in which Boeing already had a reasonable degree of experience.

Hypothesis Six Findings

> H6: International cooperative programs in which each partner's share of technological benefits is perceived as being in proportion to its contribution are more likely to be successful than programs in which shares are not so perceived.

Conclusion: H6 supported

The Boeing executives interviewed felt very strongly that on balance, the benefits received by Boeing and the program participants were generally in proportion

to the contributions made by each company. The interviewees believed that in certain aspects, Boeing benefited more than the program participants, while in other aspects the program participants benefited more than Boeing.

Some of the areas cited in which Boeing may have received more benefit than a program participant (in proportion to their overall contributions to the program) included computer-aided design, computer-aided manufacturing, composite technology (from Japan), and computational fluid dynamics. The Japanese companies in particular were very advanced in these areas, and the interviewees felt that Boeing had learned a great deal as a result of working on the program with the JADC members.

The areas cited in which the program participants may have received proportionally more benefit than Boeing included aircraft design and general airplane technology, aircraft manufacturing management, aircraft manufacturing (production) technology and configuration control.

While these areas may cause it to appear as though Boeing gave away more than it received in return, several of the executives pointed out that from a contractual standpoint Boeing also benefited proportionately more than the program participants. The final contract not only favored Boeing in the formula for revenue sharing, it also restricted the use of technology transferred between companies. All participating companies are contractually

prohibited from allowing transferred technology to be used in any airplane which might compete with any other participating company's existing family of airplanes for a period of seven years after production ends.

One obvious commercial spin-off application from the 767 program was noted by a few of the interviewees. Some of the composite technology learned by Aeritalia has been applied to their ATR-42 commuter airplane program. As previously noted in the literature review, this is a small capacity, regional commuter. At the time, this type of aircraft did not compete for its market share with any of Boeing's airplanes. The benefits from this spin-off application are not required to be shared with Boeing or JADC, but this apparently has not affected the business relationship between Aeritalia, Boeing and JADC.

The interviewees, in general, felt strongly that none of the companies involved in the 767 program had been technologically exploited or taken advantage of. One interviewee, however, expressed the concern that the technology exchange was too one-sided. He felt that Boeing had given the other companies more information and "know how" than was necessary. However, it should be reemphasized that most of the interviewees believed that, on the whole, the benefits received by each company were not disproportionate to their overall contribution to the program.

Hypothesis Seven Findings

H7: Programs in which participants have relatively more experience with international programs and with the relevant technology will more likely be successful than those in which participants have less experience.

Conclusion: H7 supported

The 767 program marked the first occasion in which the Boeing Commercial Airplane Company collaborated with a foreign company as an international risk-sharing participant. However, Boeing had extensive experience with both the Japanese and the Italian participants prior to launching the 767 program.

The 767 program's foreign participants had been involved, to various extents, in providing parts and subassemblies to BCAC for the Boeing 727, 737, 747 and 757 series airplanes. These parts and subassemblies were delivered on a subcontracting basis; the foreign companies acted strictly as suppliers without a risk-sharing role. According to a senior executive, the experience Boeing gained through their prior relationships with the program participants was enough that Boeing fairly well understood "how they [the program participants] worked."

The interviewees stated that the 767 program's key managers had little or no personal experience with program management involving foreign risk-sharing participants. But all of the key managers had previously been assigned to important program management positions on other Boeing

production programs. Most of the interviewees stated that key managers had an extensive technical background which included college degrees in engineering. One senior executive said that key managers possessed extensive technical knowledge "not necessarily by education but by experience." As another interviewee expressed it, the program management people must be able "to speak the engineer's language."

All of the interviewees felt that both technical expertise and management ability were essential in the program management office. If forced to choose between one and the other, all but one of those interviewed stated he would choose someone with proven management experience to work in a program management position. One senior executive stated that technical expertise alone was not enough, but that interpersonal skills were absolutely essential, especially since the 767 program involved foreign companies as program participants. Another executive stated that "nearly all" of the program managers at a certain level had undergraduate degrees in engineering and graduate degrees in business administration.

As a company, BCAC's experience with airplane technology is undeniably extensive. The program participants were also experienced in aircraft manufacturing to varying degrees. Boeing and the program participants had a working relationship as well as extensive contact in planning and

negotiating before the 767 Memorandum of Understanding was signed.

Hypothesis Eight Findings

> H8: International programs whose program managers and team members are more program oriented than parent [company] oriented are more likely to be successful.

Conclusion: H8 supported

All of the interviewees stated that company interests rarely conflicted with program interests. They all felt that program managers and team members were almost totally oriented toward achieving the best possible results for the program, rather than allowing parent company interests to take priority.

The one exception noted to this overall program orientation involved one of the participant companies with more than one factory location. One of the executives interviewed felt that one of the participant's factories seemed more oriented toward its work on another airplane program. This other program was a larger, more expensive, and more profitable project than the factory's workshare in the 767 program represented. Both programs were in the manufacturing and production stages at the same time and in the same factory. The interviewee stated that although this particular factory seemed more dedicated or oriented toward the larger and more profitable program, this orientation did not cause any major problems for the 767

program. All the 767 parts and subassemblies produced at this factory met or exceeded the cost, schedule and technical performance goals.

Overall, the interviewees expressed a sense that the program goals were fairly well aligned with Boeing's company goals from the outset of the 767 program. They felt that the program managers and team members never had any major difficulty in maintaining a "program first" orientation.

All of the program participants, as well as BCAC, were involved with performing functional tasks in designing, engineering and manufacturing various aircraft component parts and subassemblies. The question of specifically determining "who is going to build what components" was settled well ahead of the program launch decision. The participants' specific responsibilities were incorporated in the final contract.

When program problems did arise, most of the interviewees cited the different managerial philosophy of a foreign program participant as the most likely source. One executive characterized U.S. management style as often being more "confrontational," while the Japanese management style is more oriented toward building a "consensus" of management opinion. This resulted in some minor misunderstandings, but nothing beyond "normal business problems" according to another interviewee. One senior

executive stated that generally, Boeing also worked toward attaining a consensus in dealing with a foreign participant. Another executive stated that the Boeing program management team had to "learn to work within their (the Japanese) system but still maintain your values."

As an example of this effort toward building a consensus, an instance was cited of a conflict between a manufacturing cost reduction or an aircraft gross weight reduction. Boeing managers were able to demonstrate the performance effect of the gross weight reduction, and to convince the foreign participant that this reduction would more than offset the added manufacturing cost.

Another problem cited as being related to managerial philosophy involved the meaning of "due dates" for completing engineering drawings. One interviewee stated that the Japanese engineers and their engineering management team regarded the scheduled due date as a "target date." But the Boeing managers considered the due date as a "drop dead date" because of the possibility of requiring other due dates to slip as a result of the late completion of drawings. Once the Boeing program managers explained the real meaning and importance of the due date, and the possible problems and delays which could result, late engineering drawings were seldom a problem, and the program schedule was never delayed.

One final interesting concern, related to this issue of program orientation versus parent company orientation, arose when one senior executive discussed the marketing aspect of the 767 program. He pointed out that the program participants had been concerned that sales of other Boeing airplanes might reduce the 767's market share potential, and thus reduce the foreign participants' revenues from the program. But another executive emphasized that Boeing's policy is to sell "which ever airplane is best for the customer." The interviewees who addressed this issue felt that this was never really a major program concern for two primary reasons; Boeing still maintained the highest investment and highest risk position in the 767 program, and Boeing's customer orientation had long been established in the world's aircraft market.

Hypothesis Nine Findings

H9: Programs in which there is less environmental uncertainty will more likely be successful than programs that experience more uncertainty.

Conclusion: H9 supported

As previously explained in Chapter II, the world's commercial airplane industry is probably one of the least certain and highest risk enterprises in existence. Long lead times allow ample opportunity for unforeseeable events to intervene during the course of a program.

The Boeing 767 program was somewhat affected by environmental uncertainty, just as every commercial airplane program is affected. The two primary environmental events affecting the 767 program were the worldwide economic recession of the early 1980s and the significant decline in jet fuel prices. Both of these events had an impact which reduced the world market's demand for new fuel-efficient passenger jets. As a result, Boeing drastically reduced the 767 production rate, from a planned rate of eight to twelve aircraft per month down to an actual rate as low as two aircraft per month. This in turn caused some distinct unhappiness among the foreign program participants.

The foreign companies had been contractually required to expand their productive capacity to meet the planned production rate of eight to twelve aircraft per month. The participants had already made the large investment required to expand their capacity before the economic recession and the decline in fuel prices occurred. Boeing explained the reasoning behind the production rate slowdown, and the program participants eventually came to view the situation as a normal risk in the airplane manufacturing industry.

In addition to this drastic slowdown in 767 sales and production, the program was also affected, although to a lesser degree, by the Federal Aviation Administration

certification of the airplane. The FAA certified the 767 to operate using only a two-person cockpit crew. The first thirty aircraft had to have the cockpit rewired and reconfigured, in order to convert from a cockpit requiring three crew members to a cockpit requiring only two crew members.

Another environmental change with a lesser effect caused changes in the landing gear system. These changes were required to meet new restrictions on landings at New York's LaGuardia Airport.

In spite of these environmental changes, the 767 program adhered to the remaining cost, schedule and technical performance goals agreed to at the outset. One senior executive pointed out that the 767 "was the first new airplane program to come in under cost and on time," while meeting or exceeding all technical performance goals. Overall, the interviewees felt that the program had been exceptionally stable. None of the program participants joined late, and all of the participant companies are still active in producing the 767.

The interviewees all stated that reassignment of managers definitely did not hamper progress or cause significant problems for the program because reassignment seldom occurred until the program was pretty well matured. Two senior executives stated that they felt the 767 program ran more smoothly in part because of a "team environment";

the team stayed together from product development through design and manufacturing, and very few managers moved until the 767 was well into production.

Although there existed some major environmental uncertainties as previously explained, it is the researcher's best judgement that these constituted a more or less "normal" condition within the context of this particular industry. Production rates were planned to be flexible and the sense of the interviews was that the environment was actually fairly stable. This, coupled with the fact that the original cost, schedule and technical performance goals were adhered to throughout the program tend to support the hypothesis.

In the researcher's view, the important factor in hyposthesis nine is not whether environmental uncertainty occurs or not. This is merely happenstance. Rather, the essence of the hypothesis is whether program management anticipates uncertainties and provides mechanisms to handle uncertainties--this is how management may influence program success or failure. During the 767 program, these planned mechanisms included a steering committee, a strong program manager, harmonized goals and a cooperative "program" orientation.

Hypothesis Ten Findings

H10: Programs which are structured to minimize uniquely international concerns such as geographical separation, cultural differences, language barriers, etc. will more likely be successful than programs that do not minimize such concerns.

Conclusion: H10 supported

Boeing's 767 program managers took several steps to structure the program so as to minimize their concerns in dealing with foreign program participants. They used a combination of contract clauses and a unique program management structure to accomplish this.

Concerns dealing with geographical separation were minimized largely because: (1) Japanese and Italian engineers worked at Boeing's Seattle area plants with Boeing Engineers and Boeing engineering managers until approximately 25 percent of the engineering drawings were complete, and (2) Boeing had "on-site" teams in both Japan and Italy working for the U.S. program manager. These on-site teams were largely composed of the same personnel who worked with the Japanese and Italian engineers in the U.S. The 767 program management also had a dedicated communications system linking the three countries which included voice and graphics capability, plus a team in Boeing's U.S. plant dedicated to answering questions for the on-site teams. Finally, transportation time allowances for the geographical separation were built into the delivery schedule in the contract.

Problems concerning cultural differences were minimized by the approach taken by Boeing's on-site teams. These teams tried to work within the Japanese and Italian management systems to build a consensus with the foreign company, rather than trying to dictate how to do everything. As specified by the contract, U.S. dollars were used to determine costs and revenues, rather than Japanese yen or Italian lire. This prevented new problems from being introduced every time international monetary exchange rates fluctuated.

Language barriers were minimized because English was specified by contract to be used as the official working language of the 767 program management. The foreign companies still used their own native languages during the day-to-day operations, but the interface between Boeing's program managers and a foreign participant's program managers was always conducted in English. Several of the interviewees pointed out that many of the Boeing people on site studied Japanese or Italian in an effort to establish better working relationships with program participants. However, this was a strictly voluntary effort on the part of each individual; it was not required either by contract or by BCAC. Nonetheless, this voluntary effort is indicative of the cooperative program orientation embodied in hypothesis eight.

Problems which could have arisen due to a lack of technological capacity or resources were generally minimized from the outset of the program. The program participants agreed by contract to expand their productive capacity. Boeing agreed to transfer the technology necessary to design and produce the parts and subassemblies assigned to each program participant. To re-emphasize, thorough planning and harmonizing requirements "up front" allowed program management to foresee their needs.

Concerns related to differing management practices were generally minimized by the on-site team's managerial approach. Boeing's on-site program management people did not attempt to dictate strict procedures for, or to manage the details of every minute task being performed in a foreign participant's plant. One executive emphasized that Boeing generally monitored only the details necessary to insure compliance with Federal Aviation Administration certification procedures. As explained earlier, the on-site team generally worked within the foreign participant's system of management to foster a consensus. Another executive stated that it took a little time, but the on-site teams developed very smooth working relationships with the program participants.

Open-ended Comments

The final question asked in each interview solicited open-ended discussion from each interviewee. The following remarks applied to the program in general as opposed to any single research hypothesis. Generally, the remarks reflected points which the interviewee felt were important to emphasize.

These comments are not presented in any particular order. The context in which these remarks were made precedes each comment.

On Boeing's overall control of the program:

"Someone must take the lead."

On the working relationship with a participant company:

"You must be up front and your people must be cooperative."

On how to structure program management to accommodate foreign participants:

"There must be a dedicated group to manage the interface."

On what made the 767 program so successful at achieving cost, schedule and performance goals:

"It was well defined."
"Planning was the key."

Two of the executives interviewed made the observation that Boeing almost certainly would have "built the 767" without the program participants. However, they felt that it was better for Boeing to have JADC as a "partner" rather

than as a competitor--either because of an independent JADC entry or because of a JADC partnership with Airbus Industrie.

Finally, it was learned that Boeing managers had written a "lessons learned" report about the 767 program. However, the report was apparently considered sensitive and only a very few managers had seen it or even knew it existed. This report had not been circulated among 7J7 program management personnel.

7J7 Program Findings

The Boeing 7J7 program is still in an early stage of development. The final design and configuration of the airplane have not been decided on, and a formal program "launch decision" is not expected until mid or late 1987. But a memorandum of understanding for the 7J7 program has been signed by BCAC and JADC officials.

JADC, representing the three Japanese Heavy Industries companies, is planning to assume a 25 percent risk-sharing and work-sharing position in the program. A major difference between the 7J7 agreement and the 767 agreement is that JADC will become a full equity partner in the 7J7 program, and will thus have voting rights on program decisions.

Since the 7J7 program is in such an early stage of development, the researcher has made no attempt to

reach conclusions related to the research hypotheses. Rather, information gathered during the interviews which pertains to the 7J7 program will be presented here as information only. Conclusions related to the research hypotheses must necessarily await future researchers. The information gathered will be presented under three broad categories: program management, technology and environmental uncertainty.

Program Management. The steering group for the 7J7 program is called the Joint Program Board. The Joint Program Board is composed of senior executives from BCAC and JADC who meet quarterly and at major program decision points. JADC is represented on this board by 25 percent of the voting members. Several major program decisions, such as "program go-ahead," cost standards, and weighted revenue sharing, will require a unanimous decision.

The interviewees stated that key management people were collocated, and that program management people were were very much proactive. One interviewee felt that problems which had arisen were "no more than normal business problems," and he stated that management had "a very strong 'win-win' philosophy." All of the interviewees felt that program management was very program oriented (as opposed to parent company oriented).

Technology. Several technological advances are being considered for the 7J7 program. The interviewees cited the following advances:

1. A full "fly-by-wire" flight control system
2. Large wing sections constructed with composite materials (moving toward a composite wing)
3. Advanced software
4. Increased reliability
5. A commitment to significantly reduce the cost of the airplane
    a. "new business systems"
    b. "aggressive tool pricing"
6. A propfan engine

One of the interviewees felt that the 7J7 program was "exposed to a significant degree of risk" in attempting these technological advances. He cited a "fly-by-wire" flight control system and the software advances as being the highest risk advances.

Several of the interviewees stated that the issue of technology transfer has already caused some problems for the 7J7 program. They pointed out that some U.S. and Japanese suppliers have been reluctant to give Boeing and JADC proprietary data because these suppliers feared the data would be compromised, possibly putting their competitive positions in danger. The interviewees all felt that the technology transfer issue would be eventually resolved

through some sort of compromise. Two of the interviewees stated that they were very concerned that Boeing would be transferring too much technology during the 7J7 program.

Environmental Uncertainty. The interviewees cited two major elements of environmental uncertainty as having the most potential impact on the 7J7 program. The element of uncertainty most often cited was how the price of jet fuel may affect the potential market for the 7J7. Lower fuel prices could make the 7J7 less attractive to potential customers than less expensive, older technology airplanes. The recent sales success of the Boeing 737-400 was specifically cited, since orders for this aircraft have exceeded production capacity.

The second element of uncertainty cited by the interviewees was the still-flexible configuration of the 7J7. One interviewee remarked that developing a new airplane configuration was like "satisfying a moving target." Another interviewee felt that "changing directions" caused JADC more problems (because of Japanese managerial philosophy) than it caused Boeing.

V. Summary, Conclusions and Recommendations

Chapter Overview

The first part of this chapter summarizes the purpose of this study and the approach taken to the research. The next section states the conclusions drawn from this study. The chapter concludes by suggesting directions for further research.

Summary

During the past fifteen years, international cooperation has become the dominant business strategy among the free world's commercial airplane and jet engine manufacturers. As documented in Chapter II, international cooperation is being used to reduce risks, improve market access, reduce competition and rationalize resources. This trend toward forming international partnerships to develop new commercial airplanes and the engines to power them is expected to continue.

In spite of this growing trend toward "internationalization" of an extremely high-cost industry, very little has been written concerning the complex management issues which may affect the success of an international venture. The purpose of this study was to contribute to the understanding of how specific management techniques

and policies affect the success of an international cooperative program.

The Boeing 767 airplane program was selected for a case-study analysis. The methodology and research hypotheses developed by Charles M. Farr were replicated during the research. Personal interviews with knowledgeable Boeing executives yielded an in-depth understanding of the management techniques and policies used during the 767 program. The research hypotheses were then evaluated in view of the knowledge gained from these interviews, as well as secondary sources when possible.

Conclusions

Based primarily on the personal interviews conducted and, to a lesser extent, the research literature available, several conclusions may be drawn.

First of all, all ten of the research hypotheses were supported by the findings of this particular case study. These hypotheses addressing program management structure, technology-related factors and contextual environment served as a sound framework for investigating the complex management issues involved in international cooperative projects. The interviewees did not know specifically what the hypotheses stated. However, their comments (when asked if anything important in their experience

had been overlooked) indicated that the interview guide was extremely thorough.

Next, based on cost, schedule and technical performance goals, the nonwithdrawal of any participant, and the perceptions of key people knowledgeable about the program, the Boeing 767 program was indeed a success. Only time will tell whether the program will prove to be a commercial success--that is, whether sales will reach a break-even point or eventually generate a profit. Many more years may be required to reach this break-even point, but that is the nature of this industry. However, from the management standpoint, based on the stated criteria for this research, the 767 program was highly successful.

Further, the principal factors most directly responsible for this success appear to have been very strong program leadership, extensive and careful planning, as well as a spirit of forthrightness and cooperation. A high-level steering committee apparently worked to make the best possible decisions in terms of the total program. A high-ranking program manager ran a very smooth program. Comprehensive planning ensured that program goals were understood and agreed upon in advance, that most foreseeable contingencies were accounted for, and that the entire effort was well integrated. Management's emphasis on being "up front" and cooperative appeared to have been a

key factor in fostering good working relationships and a "program first" spirit.

Next, international cooperation appears to be a growing trend in the commercial airplane industry as well as other industries. The economic and political factors which have motivated the formation of international consortia or partnerships are likely to persist in the foreseeable future. To counter these factors, the business strategy of international cooperation is also likely to persist.

In addition, there is significant evidence that U.S. aircraft manufacturers may be facing a serious threat to their ability to compete in the future world market. High levels of foreign government subsidies, as well as political pressure exerted on customers, could further erode the competitive position of U.S. manufacturers.

Next, this case-study analysis of the Boeing 767 program tended to support most of the "management principles" suggested in Farr's research of military programs involving international cooperation. The principles supported were:

1. A high level forum, such as a steering committee, should be used to resolve issues and provide strategic guidance.
2. The international partners of a cooperative project should grant a high level of authority to a single manager, who directs an internationally staffed, co-located project team.
3. [Not supported]

4. The goals and objectives of each international participant must be clearly identified, and formal mechanisms structured at the outset so that these various goals can be achieved.

5. Technological advance should be attempted in an evolutionary, incremental fashion.

6. Extra care should be taken to structure a program in which benefits are equitably distributed and in which all participants are "equally happy or unhappy" with the results.

7. Government and industry members of the project team should be carefully chosen to maximize experience along the following dimensions: managerial experience, international experience, and experience with the relevant technology.

8. There should be active planning for and anticipation of various environmental/external influences such as inflation; unplanned cost, schedule, and production volume changes; increased threat of war; etc.

Finally, the research indicates the importance of emphasizing that international cooperation should not be viewed as "just business as usual." As Farr has stated:

> Previous researchers have noted that some of the ideas reflected in the hypotheses may seem "obvious," "too easy," or "just common sense." However, effectively transferring these principles into practice continues to be elusive in many instances. This research underscores once again that good management, as with many other endeavors, requires careful attention (not just lip service) to the basics. (10:70)

The "basics" of the 767 program such as strong leadership, thorough definition and planning, and a spirit of cooperation, took more than common sense--they took <u>years</u> of work.

Recommendations

This research study suggests three areas for further research:

1. The current study could be expanded to include surveying JADC and Aeritalia executives. This may add further insight to the research findings.

2. Replications of Farr's research could be extended to a larger sample of international cooperative ventures, such as the mature programs listed in Chapter II of this study. Eventually, a large enough sample may allow a statistical model to be designed so as to validate the effect of management factors on the success of an international cooperative program. I strongly recommend that researchers use personal interviews to increase the likelihood of a worthwhile research effort.

3. Further research should investigate the competitive outlook for U.S. commercial aircraft and jet engine manufacturers. These manufacturers are extremely important to the U.S. defense industrial base and thus, critical to U.S. national security.

In closing, I would recommend that all DoD program managers of international cooperative projects insure that a useful "lessons learned" type report is accomplished. A great deal of work, expense and learning occurs during a program; passing on to future program management offices what has been learned may save some of the work and expense.

Appendix A: Interview Guide

Name/Phone #: _____ (___) ___ - _____

Job Title: _____

_____

_____

THE FOLLOWING QUESTIONS ARE RELATED TO THE RESEARCH HYPOTHESES

_____

(H1) STEERING GROUPS

1. **Is the program guided by a steering group?**

   Yes **No**

   If yes, answer questions 2 - 9
   If no, answer questions 10 - 13

2. **Are all international partners represented in the group?**

   Yes **No**

3. **Is representation equal or in some proportion to each participant's contribution to the program?**

   Equal **Proportion (explain)**

4. **Does the group have real decision authority.**

   Yes **No**

5. Does it render timely decisions on issues / problems that arise?

Yes No

6. How often does it meet? Weekly / Monthly / Quarterly
Other _____

7. Are steering group members or other key management people co-located?

Yes No

8. Are members of relatively high rank (compared to daily program team)?

Yes No

And are members generally considered competent and of high "status?"

Yes No

9. Has the steering group generally helped or hindered program progress?

Helped Hindered

Explain (then proceed to Section III on page 3)

10. Since your program did not have a steering group, describe the alternative management structure (use diagrams or any other useful aids):

11. How are issues/problems resolved?

12. Are decisions timely? Explain.

13. How has this structure helped or hindered program progress?

(H2) PROGRAM MANAGEMENT AUTHORITY

1. Does the program manager(s) have sufficient authority to make important decisions, resolve conflict, etc. without undue interference or frequent higher level overturning of decisions?

Yes No

Explain

2. Is ultimate decision authority vested in a single recognized leader; or does split authority exist?

Single Split

Explain

3. Is management generally proactive or reactive?

Proactive Reactive

Explain

(H3) PROGRAM SIZE

1. What is the approximate dollar investment in this program?

2. Approximately, how many people are there in the program office?

3. What is the title / rank of the program director?

(H4) HARMONIZING OF REQUIREMENTS

1. To what extent did all international partners contribute to specifying desired operating characteristics, cost goals, schedule goals, etc. of this program?

   Not at all 1 2 3 4 5 6 7 A great deal

2. Did the requirement for this program originate as a strongly perceived <u>need</u> by the airline industry?

   Yes No

3. Were the joint requirements / objectives of the program specified at the outset, or were significant decisions deferred until later in the program?

   Outset Deferred

   Explain
   What was the effect on program success?

4. Did the program experience any serious interface or integration problems that resulted (or could have resulted) from failure to harmonize requirements / objectives?

   Yes No

   Explain

5. Was there any strong political pressure to make decisions that were less than desirable (to either the program office or to potential customers)?

   Yes No

   Explain

(H5) STATE-OF-THE-ART ADVANCE

1. The technical advances attempted by this program were

None, completely proven technology — Large, "Star Wars"

1 2 3 4 5 6 7

2. Briefly describe the major advances, if any _____

_____

_____

(H6) DISTRIBUTION OF BENEFITS

1. In your opinion, are the benefits received by each partner in proportion to the contributions made by each partner?

Yes No

Explain

2. To your knowledge, did (do) any partners feel that they were "exploited" technologically?

Yes No

Explain

3. Are there any obvious commercial spin-off applications from the program?

Yes No

4. If so, are the resulting benefits shared by all partners?

5. If not all participants share potential spin-off benefits, how has this affected partner relationships?

(H7) EXPERIENCE WITH INTERNATIONAL PROGRAMS AND RELEVANT TECHNOLOGY

1. How many previous international programs has Boeing been involved with?

2. Have any of the partners worked together before?

Yes No

Explain

3. How many times have key managers previously occupied important management positions on programs of this type (answer for the 2 or 3 most key management positions)?

4. Did (Do) key managers also possess technical knowledge and training?

Yes No

5. If forced to choose a manager with technical expertise or proven management experience, which would you choose? Why?

(H8) PROGRAM ORIENTATION VERSUS COMPANY ORIENTATION

1. When company interests /desires conflict with the best interests of the program as a whole, are program managers and team members more oriented to the best results for the program or do they tend to put company interests first?

Program Company interests

Explain

2. Do most program members perform functional tasks (manufacturing, engineering, etc.)?

Yes No

3. In your experience, when problems arise do they tend to stem from problems with the foreign partner's bureaucracy, economy, managerial philosophy, etc.; or are problems more likely from the U.S. partner's sources?

Foreign Partner U.S. Partner

Examples

(H9) ENVIRONMENTAL UNCERTAINTY

1. Circle any of the following types of unplanned changes that have affected this program? Budget / Schedule / Inflation / Protectionist Legislation / Other

Describe the effect on the program

2. Has any partner altered its goals / requrements after the program had begun because of political pressure or other reasons?

Yes No

Describe the effect on the program

3. Have any participants withdrawn, or did any partners join late?

Yes No

Explain

4. To what extent does reassignment / rotation of managers hamper progress and/or cause significant problems?

Not at all 1 2 3 4 5 6 7 A great deal

Explain

(H10) DESCRIBE THE EXTENT TO WHICH THE FOLLOWING CHARACTERISTICS OF YOUR PARTNERSHIP WITH AERITALIA HAVE AFFECTED PROGRAM SUCCESS:

	Not at all						A great deal
Geographical Separation	1	2	3	4	5	6	7
Cultural Differences	1	2	3	4	5	6	7
Language Barriers	1	2	3	4	5	6	7
Differing Technological Capacity / Resources	1	2	3	4	5	6	7
Different Managerial Practices	1	2	3	4	5	6	7

(H10) DESCRIBE THE EXTENT TO WHICH THE FOLLOWING CHARACTERISTICS OF YOUR PARTNERSHIP WITH JADC HAVE AFFECTED PROGRAM SUCCESS:

	Not at all						A great deal
Geographical Separation	1	2	3	4	5	6	7
Cultural Differences	1	2	3	4	5	6	7
Language Barriers	1	2	3	4	5	6	7
Differing Technological Capacity / Resources	1	2	3	4	5	6	7
Different Managerial Practices	1	2	3	4	5	6	7

THIS PART ASKS YOU TO RATE THE SUCCESS OF YOUR PROGRAM AND MAKE ANY ADDITIONAL COMMENTS THAT YOU FEEL ARE IMPORTANT

1. Please rate your program's performance in the following areas:

	Highly Successful						Highly Unsuccessful
Cost Performance	1	2	3	4	5	6	7
Schedule Performance	1	2	3	4	5	6	7
Technical Performance	1	2	3	4	5	6	7
Achievement of Offset Goals	1	2	3	4	5	6	7

2. Is there anything important in your experience that seems to have been overlooked? Feel free to attach memos, references, or other documents that might illustrate your point.

THANK YOU VERY MUCH FOR YOUR ASSISTANCE WITH THIS STUDY!

Appendix B: Interview List

Mr. Murray Booth, Chief Project Engineer, 7J7 (formerly Chief of Technology, 767). Renton WA, June 24, 1986.

Mr. Ray Brandon, Structures Design Manager, Renton Division (formerly Engineering Manager, Japan). Renton WA, June 26, 1986.

Mr. Jurgen Danitschek, Structural Design Engineering Manager, BCAC (formerly Engineering Manager, Italy). Kent WA, June 23, 1986.

Mr. Mark Gregoire, Director 737/757 Marketing Management. Renton WA, June 27, 1986.

Mr. Peter Morton, Director of Cost and Program Management, 7J7. Renton WA, June 24, 1986.

Mr. Harry Olsen, Design to Build Manager, 7J7. Renton WA, June 25, 1986.

Mr. Roy B. Phillips, Program Management Manager, 7J7. Renton WA, June 25, 1986.

Mr. Arthur G. Ponti, Director of Materiel, 767 (formerly Director of Major Outside Production/Program Participants, 767). Renton WA, June 24, 1986.

Mr. Neil W. Standal, Director, Renton Division Program Management (formerly Director of Program Management, 767). Renton WA, June 26, 1986.

Bibliography

1. "Boeing, Aeritalia Sign 767 Agreement," Aviation Week and Space Technology, 109: 24 (August 21, 1978).

2. Boeing Commercial Airplane Company. International Competition in the Production and Marketing of Commercial Aircraft, The Boeing Company, Seattle WA, May 1982.

3. "Boeing: The Higher the Flight, the Farther to Fall," The Economist, 299: 23-26 (May 3, 1986).

4. "Boeing, Japan Sign Work Share Pact for 7-7," Aviation Week and Space Technology, 120: 32 (March 19, 1984).

5. "A Boeing Partnership Will Be Slow to Lift Off," Business Week, 2836: 45 (April 2, 1984).

6. Brown, David A. "Short Brothers, Saab-Scania Join Boeing 7J7 Program," Aviation Week and Space Technology, 124: 32-33 (March 31, 1986).

7. Clutterbuck, David. "The Jigsaw with Bits in Three Countries," International Management (UK), 36: 16-18 (August 1981).

8. Emory, C. William. Business Research Methods (Third Edition). Homewood IL: Richard D. Irwin, Inc., 1985.

9. "Fairchild Withdrawing from 340 Aircraft Project," Aviation Week and Space Technology, 123: 23 (October 21, 1985).

10. Farr, Maj Charles M. An Investigation of Issues Related to Success or Failure in the Management of International Cooperative Projects. PhD dissertation. University of North Carolina, Chapel Hill NC, 1985.

11. Fink, Donald E. "Pratt, Rolls Launch New Turbofan," Aviation Week and Space Technology, 119: 28-29 (November 7, 1983).

12. Gallagher, Brendan (ed.). Illustrated History of Aircraft. Norwalk CT: Longmeadow Press, 1977.

13. "International Cooperation," Aviation Week and Space Technology, 118: 78-321 (May 30, 1983).

14. "International Joint Ventures," Aviation Week and Space Technology, 122: 116-357 (June 3, 1985).

15. International Trade Administration. A Competitive Assessment of the U.S. Civil Aircraft Industry. Report No. PB 84-154913. Washington: Department of Commerce, March 1984.

16. Moxon, Richard W. and J. Michael Geringer. "Multinational Ventures in the Commercial Aircraft Industry," Columbia Journal of World Business, XX: 55-62 (Summer 1985).

17. Office of the Undersecretary of Defense for Research and Engineering. Report of the Defense Science Board Task Force on Industry-to-Industry International Armaments Cooperation Phase I--NATO Europe. Washington: Department of Defense, June 1983.

18. -----. Report of the Defense Science Board Task Force on Industry-to-Industry International Armaments Cooperation Phase II--Japan. Washington: Department of Defense, June 1984.

19. O'Lone, Richard G. "New Efforts Task Japanese Firms," Aviation Week and Space Technology, 109: 31-33 (October 2, 1978).

20. Peat, Marwick, Mitchell, and Company. F-16 Program Lessons Learned Study. Peat, Marwick, Mitchell, and Company, Durham NC, April 22, 1980.

21. Senia, Al. "Will It Be 'Honda' in the Skies Next," Iron Age, 228: 38-41 (May 17, 1985).

22. Smith, Bruce A. "Douglas, China Sign MD-82 Coproduction Agreement," Aviation Week and Space Technology, 122: 31-32 (April 22, 1985).

Vita

Major Michial G. Farrell was born in Eindhoven, The Netherlands on 3 November 1950. After graduating from high school in Bellevue, Washington, he entered the United States Air Force Academy from which he received the Bachelor of Science degree in General Studies in June 1973. He completed pilot training at Reese AFB, Texas and received his wings in November 1974. He then served as a C-130 pilot with the 776th Tactical Airlift Squadron at Clark AB, Philippines until December 1975, when he was reassigned to McChord AFB, Washington. While stationed at McChord, Major Farrell served as a C-130 pilot and instructor pilot with the 36th Tactical Airlift Squadron, and as a simulator instructor and flight examiner with the 62nd Military Airlift Wing. In October 1982, he was reassigned to the 374th Tactical Airlift Wing at Clark AB, Philippines where he served as an Airlift Control Element operations officer and a Current Operations scheduling officer. During this tour of duty at Clark, Major Farrell earned the degree of Master of Science in Systems Management from the University of Southern California. He entered the School of Systems and Logistics, Air Force Institute of Technology in May 1985.

Permanent address: 14314 137th Avenue East
Puyallup, Washington 98373

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During the past 15 years, international cooperation has become the dominant business strategy among the free world's commercial airplane and jet engine manufacturers. International cooperation is being used to reduce risks, improve market access, reduce competition and rationalize resources. This trend toward forming international partnerships to develop new commercial airplanes and the engines to power them is expected to continue.

The purpose of this study was to contribute to the understanding of how specific management techniques and policies affect the success of an international cooperative program. The research identified factors which could have a significant influence on the successful management of such a program.

The Boeing 767 airplane program was selected for a case-study analysis. The methodology and research hypotheses developed by Charles M. Farr were replicated during this research. Personal interviews with knowledgeable executives from the Boeing Commercial Airplane Company were conducted. The research hypotheses were evaluated based on data from the interviews and secondary sources (when possible).

Based on the case-study analysis as well as the research literature, conclusions regarding the management factors addressed in the research hypotheses are stated, and several principles for managing an international cooperative program are reiterated.