STUDY PROJECT

THE JAPANESE AEROSPACE INDUSTRY: IS THE SUN RISING ON THE WORLD MARKET?

BY

COLONEL R. GUY BENT II
United States Air Force

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USAWC MILITARY STUDIES PROGRAM PAPER

THE JAPANESE AEROSPACE INDUSTRY: IS THE SUN RISING ON THE WORLD MARKET?

by

Colonel R. Guy Bent II
United States Air Force

Dr. Thomas L. Wilborn
Project Adviser

U.S. Army War College
Carlisle Barracks, Pennsylvania 17013

ABSTRACT

AUTHOR: F. Guy Bent II, Col, USAF

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Immediately after World War II, the U.S. occupation of Japan banned aircraft manufacturing, prohibited any aircraft research and development, and split the major aircraft corporations into smaller enterprises. This continued until 1952 when Japan regained its sovereignty and the authority to manufacture aircraft. Slowly, Japan began rebuilding its industry. Initially, this took the form of repairing and maintaining U.S. aircraft. Later they entered into a coproduction agreement with the United States and built the F-86, the first of what would be a long series of military aircraft the Japanese would build under license production agreements with American manufacturers. As the Japanese aerospace industry matured, they domestically produced military and commercial aircraft to meet their goal of becoming a leading producer of aircraft for the world market. When their efforts met with limited success, they entered into joint ventures with international companies to increase their experience base and share the risks and extremely high costs associated with aircraft manufacturing. This paper reviews the Japanese aerospace industry from the period after World War II to the present, and then looks at the future prospects for the industry. Based on their past performance in the aerospace industry and other high technology industries, there is every potential for Japan to become a leading producer of aircraft for the world market.

INTRODUCTION

For a 7-year period following World War II, the United States prohibited Japan from manufacturing aircraft while the rest of the world entered the jet age. In 1952, the Japanese began to rebuild their aerospace industry. At first this took on the form of maintaining and repairing U.S. aircraft assigned to Japan or involved in the Korean War. When they began to manufacture aircraft, their first strategy centered around coproducing aircraft under license agreements with U.S. companies. The F-86 Sabrejet was the first of what would be a long line of mainly military aircraft Japan would coproduce with the United States. As the Japanese acquired technology and gained experience, they started producing domestically manufactured aircraft to meet some of their military and civil needs.

Japanese companies first ventured into the commercial aircraft market when they built the YS-11. From a technical standpoint, the aircraft was a success; but, economically the aircraft busted when it failed to show a profit. This failure did not deter the Japanese from all domestic production. They produced several successful aircraft for the Japan Defense Agency (JDA) while they continued to coproduce aircraft with the United States.

With a public goal of becoming a world leader in the aerospace industry, Japanese firms reentered the commercial market by teaming with foreign companies in international joint ventures. These ventures, principally with U.S. firms, allowed Japan to acquire advanced, high technology, and an experienced labor force while they continued to expand their own research and development (R&D).

Following a series of successful ventures with the Boeing Aircraft Corporation, Japanese companies started to make some inroads in the commercial market. Though still small compared to their American competitors, the Japanese were not content to stay in the background.

Their world leadership in key technologies convinced them they could successfully compete on the world market and someday become a world leader in the aerospace industry. With a full menu for the future and a proven recipe for getting there, the Japanese are not looking back.

This paper will review Japan's rebirth in the aerospace industry after World War II, its status in the marketplace, and outline the prospects for the future.

BACKGROUND

Japan's aircraft development began in the 1920s and 1930s through license agreements with foreign countries. By the late 1930s Japan developed its own aircraft and amassed a significant air force. During World War II, many independent producers built aircraft using the most advanced designs. Mitsubishi Heavy Industries built 10,500 Zero fighters and the Nakajima Company, the predecessor of today's Fuji Heavy Industries, built nearly 26,000 aircraft.[1] At the peak of World War II, Japan's aerospace industry produced 25,000 aircraft and 40,000 aircraft engines while employing 600,000 workers.[2]

Near the end of the war, the military oversaw Japan's large, technically advanced aircraft industry. By 1944, 12 independent

aircraft manufacturers and 7 engine producers remained in business; however, the demilitarization of Japan after the war decimated the industry.[3] U.S. occupation of the country banned all aircraft manufacturing, prohibited any aircraft R&D, and split the major corporations into smaller enterprises. Further, manufacturing facilities were designated as reparations, aircraft laboratories were either removed or destroyed, and expert aerospace engineers that supported the industry dispersed throughout the country. These measures effectively killed the aircraft industry.[4]

In the early post World War II era, Japan lost its independence in military power when the United States banned the development of military technology. This led Japan to concentrate its resources on civilian technology, much of it imported from the United States. From 1945-1952 Japanese companies did not produce a single aircraft when the world's aircraft industry grew rapidly, shifting from piston-engine to jet-engine aircraft technology. This 7-year gap in production placed Japan at a huge disadvantage in comparison to other countries.[5] When the United States lifted this ban, the rest of the world had entered the jet age, while Japan lagged for behind.

In 1952, Japan regained its sovereignty and the authority to manufacture aircraft. Slowly, they began to rebuild their aerospace industry with help from U.S. companies. Initially, this took the form of repairing and maintaining F-86 and T-33 aircraft assigned in Japan or involved in the Korean War since there was not any domestic civil or military demand for aircraft. This work

allowed the Japanese to gain more modern technology and formed the basis for the industry producing new military aircraft for the JDA.[6]

When Japanese companies began building aircraft, the government encouraged consortiums. Legislation, such as the First Aircraft Industry Promotion Law of 1954, elicited cooperation among companies and divided every major aerospace project so all the large companies participated.[7] Japan quickly formed a defense council, adopted a 3-year plan for building its defense forces, and officially interpreted the war-renouncing Article IX of its constitution as permissible for defensive weapons. The defensive interpretation accounted for the unusual terms used to describe military organizations--the Air Self Defense Force (ASDF), the Maritime Self Defense Force, and the Ground Self Defense Force. Motivated by the ongoing Cold War, the United States helped Japan rearm.[8]

COPRODUCTION--THE REBUILDING STRATEGY

The 1954 Mutual Defense Assistance Agreement between the United States and Japan provided the basis for U.S. grant-aid, Foreign Military Sales (FMS), and coproduction of weapon systems. The term coproduction refers to the program where countries join in producing a military system or item. This combined effort may be government-to-government, industry-to-industry, or a mix of government and private resources. Coproduction projects may be implemented either through the FMS program or by designated commercial firms through specific licensing arrangements.[9]

The first strategy the Japanese government used to begin rebuilding its aerospace industry was through coproduction agreements with the U.S. The United States entered these agreements to meet its national security needs with Japan. These included: (1) enabling Japan to improve military readiness through expansion of their technical and military support capability; and (2) promoting the standardization of military materiel and equipment to expand multinational operational capabilities.[10]

North American Aviation's F-86 Sabre was the first of what would be a long series of military aircraft the Japanese would build under license production agreements with American manufacturers. Under these arrangements, both governments signed a Memorandum of Understanding (MOU) for each project. The Japanese manufacturers then produced the equipment under technical assistance contracts with the companies that initially developed and produced the equipment.[11] One unique feature of this first agreement, and subsequent agreements, was the collaboration arranged by the Japanese Ministry of International Trade and Industry (MITI) of the firms that control more than 90 percent of the prime contractors in Japan. These firms, referred to as the "big four", are Mitsubishi Heavy Industries, Kawasaki Heavy Industries, Ishikawajima-Harima Heavy Industries, and Fuji Heavy Industries.[12]

When the United States and Japan initiated licensed production talks, they ended up signing MOUs at the government level and left the respective aerospace companies to work out the details

transferring technology for production. Under the Military Assistance Program, the United States contributed funds to pay for a percentage of the costs of producing U.S. aircraft in Japan in addition to transferring the necessary technology. These funds continued until 1964 when the Japanese government assumed the entire cost of producing aircraft under license from American companies.[13]

Early aircraft coproduced with the United States included jet trainers, first-generation jet fighters, helicopters, and maritime patrol airplanes. Following these efforts, Japan coproduced more advanced fighter aircraft, including the F-104J and F-4EJ, and several types of helicopters. A Rand Corporation study of these coproduction programs concluded that American aircraft industry representatives allowed Japanese companies full access to all technical information. An aerospace executive said, "We were paid to put them in business and we gave them everything we had."[14]

While coproduction of American military aircraft expanded Japan's aerospace industry, some domestic R&D and prototype production progressed under programs managed by the JDA. Initially, they developed and produced some jet trainers and the F-1 fighter. Later on, their aircraft engine industry followed a progression similar to aircraft. Engine repair maintenance evolved into licensed production and eventual domestic development.[15]

In the mid-1960s, when American defense contractors received intense competition from European defense manufacturers, Japan continued to do business with the United States as it continued to

develop its domestic defense industry. The reason was that the U.S. offered the F-4 Phantom for licensed production.[16]

The United States and Japan believed coproduction programs best served the interests of both countries. The Department of Defense (DOD) encouraged coproduction to promote standardization and interoperability, and to improve military readiness and capability. Coproduction also helped curtail the competition American aircraft manufacturers began to experience from the Europeans during the 1960s. From Japan's standpoint, coproduction stimulated the development of its industrial base to produce high technology equipment and expand the skilled employment base. This gained Japan a modern aircraft manufacturing capability while meeting the needs of the ASDF.[17]

Over time, the U.S. coproduction programs introduced engineering technology and quality control techniques. With each new military aircraft program licensed through the United States, Japan's aircraft industry increased the quantity and quality of domestically produced equipment. The licensed production programs helped Japan develop an infrastructure of suppliers for aircraft parts and equipment, applicable to both military and civilian aircraft, plus management and labor experience in aircraft production.[18]

The Japanese government's preference for coproduction stemmed from the unreliability of the DOD's FMS program. The complaints included long lead times ordering and receiving equipment, extended time repairing equipment previously acquired, and wild fluctuations

in price and cost information. This being the case, the Japanese government realized the development and production of advanced weapon systems required the most modern technology, involved significantly large investments, and took a long time. However, purchasing vice developing denied Japan the opportunity to use defense production to expand its high technology industrial base, become self sufficient in its defense equipment, and apply the crossover technology to its civilian aircraft industry. Therefore, they preferred to rely on coproduction to the maximum extent possible and to import finished defense equipment only as a last resort, even when it meant having to pay 2-3 times more to build the aircraft domestically. Coproduction allowed Japan to obtain advanced technology, enhance its advanced technology labor force, and develop and maintain a robust defense industry for eventual self-sufficiency.[19] American defense firms found the coproduction licensing agreements with Japan highly profitable, though some executives privately conceded that they were creating future competitors.[20]

Japanese firms produced under licensed agreements increasingly sophisticated combat jets. These included: the F-86 Sabrejet in the mid-1950s; the F-104 Starfighter in the late 1960s; the F-4 Phantom in the mid-1970s; and the F-15 Eagle in the early 1980s. These coproduction deals were much more expensive than buying the aircraft off-the-shelf from American companies. However, the government justified the extra cost as an offset to long-term economic benefits. It definitely wanted to develop and maintain a

viable defense industry that would increase its military self-sufficiency, obtain advanced technology and much-needed expertise, and enhance its high-technology labor force.[21]

A case in point occurred in 1978 when the Japanese government decided to coproduce the American-made F-15 fighter rather than buy it outright. If the United States government had not agreed to the Japanese desire, then Japan would have coproduced the Mirage from France, the Viggen from Sweden, or the Tornado jointly developed by Great Britain, West Germany, and Italy. While none of these weapon systems possessed the technical sophistication of the F-15, the Japanese would have decided to coproduce a less capable aircraft instead of buying the F-15 or trying to develop its own aircraft.[22]

The F-15 coproduction program began when the Japanese government targeted its aircraft industry, as well as other high-technology industries, for development. The government steadily reduced the importance of its lower technology industries, such as shipbuilding, and opted to develop high-technology export industries like aircraft production. Japan's major aircraft manufacturers expanded and upgraded their production facilities to handle their F-15, P-3C, and civil programs. Through these military and civil programs, combined, Japanese companies expanded their production capacity, technology base, and aircraft production labor force.[23]

Besides gaining advanced manufacturing equipment associated with the coproduction programs, Japanese firms benefitted from the experience their employees received from their American

counterparts. McDonnell Douglas stationed 40 technical assistance personnel in Japan to support the Japanese companies involved in the F-15 license agreement. Additionally, McDonnell Douglas trained many of the Japanese employees in the United States to support the F-15 program.[24]

The technology transfers associated with the F-15 were authorized under a MOU negotiated by the DOD and the government of Japan. The MOU specifically listed the technologies not releasable to the Japanese for national security reasons. However, since 1978, the Japanese government repeatedly requested and successfully negotiated release of much of this technology. These transfers added to their experience and technological capability in aircraft production.[25]

To support coproduction efforts, Japan's aircraft producers made large capital investments in new plant facilities and advanced equipment. Mitsubishi built another aircraft plant to supplement its parts manufacturing for the F-15. Kawasaki erected several additional facilities and purchased advanced electronics testing kits to support its production of the P-3C. To produce items for their F-15 license agreement, both companies bought new equipment for composite material bonding, titanium pressing, titanium chemical milling, new aircraft profilers, siding presses, and modern heat treatment facilities and equipment.[26]

Not surprisingly, some of the advanced technology available through military coproduction programs had commercial applicability. From the F-15 program, Japanese companies applied

the composite, avionics, instrumentation, and propulsion technologies to their civil aircraft production. Common tooling and machinery technologies benefitted both military and civil aircraft production. For example, it was not unusual to mix military and civilian aircraft on a common assembly line throughout the production process. The military production programs and their advanced technologies definitely boosted Japan's civil aircraft production.[27]

The General Accounting Office confirmed this when it studied the coproduction agreement on the F-15 program in 1982. It found Japanese firms investing in equipment and training to build parts from highly advanced lightweight materials, including titanium, boron, and carbon. Shortly after Mitsubishi assembled the country's coproduced version of the F-15, the firm produced a new corporate jet, called the MU-300 Diamond, using some of the same F-15 technologies and on the same production line.[28]

Despite advances in its aerospace industry, the lack of experience in systems-level R&D design, systems integration, and international sales and support continued to cause problems for the Japanese. The mainstay of their aerospace industry continued to be licensed coproduction of U.S. military aircraft, where R&D had long been completed and all systems integration problems solved. Coproduction, even with increased percentages of Japanese participation, did little more than follow a recipe. They often referred to it as the transfer of "know-how" and not "know-why."[29]

Almost 30 years of coproduction of U.S. military aircraft aided the growth of the Japanese aerospace industry by transferring technology and building an aircraft production base. While the F-15 and other coproduction programs transferred technology applicable to the civil sector, Japan continued to make gains from ventures it entered through civil programs with other countries.[30]

DOMESTIC PRODUCTION--THE FORMATIVE YEARS

Throughout the 1950s, Japanese companies used license agreements to build their technology base and venture into the aircraft design arena. They first ventured into the civil aviation market with the YS-11, a small, self-developed commercial aircraft with 50-60 seats. The aircraft plans began in 1959 when MITI formed the Nihon Aeroplane Manufacturing Company, a consortium of nearly all the aircraft companies with experience in building airplanes (Mitsubishi, Kawasaki, and Ishikawajima-Harima). In 3 years the first aircraft rolled off the assembly line and deliveries began in 1965 to mostly domestic regional airlines and government agencies.[31]

All of the country's heavy industrial and related components manufacturers participated in the YS-11 project. In this consortium, the government assumed 50 percent of the equity and paid all development costs. The formula offered little private incentive for market analysis or cost reduction.[32]

Over a 10-year period, the consortia built 182 of the turbo prop aircraft. Throughout the production cycle, severe production delays plagued the aircraft's manufacture. When the aircraft

failed to attract foreign sales, the consortium experienced huge losses and stopped production in 1974. Ultimately, the program suffered losses more than four times its capitalization.[33]

The Japanese declared the aircraft a technical success, but it flopped commercially because they did not know how to properly market the aircraft. A Mitsubishi executive described the experience very succinctly.

> We learned that you can't just design and produce a commercial airliner. You must conduct market research and help your client carriers survey their own markets, provide them with advice on fleet composition, price the product in the right range, and after delivery you have to be able to provide product support and perfect maintenance assistance. If you aren't able to do these things, you can't be a real civil aircraft supplier.[34]

After the three manufacturers and MITI ceased production, they decided to pursue less ambitious strategies for developing a commercial aircraft industry.

As the Japanese aircraft industry matured, it became more skilled in R&D and production. Their success with coproducing U.S. military aircraft encouraged them to domestically produce their military aircraft. Again, using a consortium arrangement, they manufactured the T-1 intermediate jet trainer, the PS-1 anti-submarine flying boat, the C-1 transport, the T-2 supersonic trainer (the first supersonic aircraft designed and produced in Japan), the F-1 fighter (a derivative of the T-2), and the T-4, their most advanced training aircraft.[35]

THE ROLE OF THE MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY (MITI)

The government of Japan through MITI played a key role in developing Japan's aircraft industry because aircraft development,

production, and marketing involved such high financial risk. MITI directly contributed to the development and strategy of Japan's aircraft industry in several ways. These included forming a consortia of domestic manufacturers, government assistance, and direct financial support for international joint venture projects. MITI policy for these projects provided 75 percent of the initial development costs, 66 percent of the flight test/prototype production costs, and 50 percent of the remaining development costs. These funds were repayable only if the particular project returned a profit. From 1978-1981, MITI supplied more than $100 million for Japan's share of two major joint venture projects, the B-767 and the RJ-2500, addressed in more detail later in the paper. During the same period, MITI's financing of civil aircraft and engine programs increased by almost 300 percent.[36]

MITI exercised significant influence over the type and numbers of aircraft production directed into the domestic aircraft industry. Based on mission requirements, the JDA selected and purchased aircraft to meet its needs. If the JDA decided to purchase a foreign aircraft, then MITI evaluated the impact on the domestic industry. MITI's guidance and recommendations influenced whether to import or license produce foreign military aircraft. Once that decision was made, MITI made recommendations to JDA on contract awards based on its knowledge of Japanese manufacturers and their status of orders.[37]

MITI's interest in expanding the developing Japanese aerospace industry was supported by the JDA decision to license produce the

F-15 and P-3C. Both programs, plus commercial joint ventures, provided the aircraft industry new technology and know-how to maintain an experienced work force. MITI believed that technological developments of Japan's civil and military aircraft programs mutually supplemented and complemented each other. Development and manufacturing techniques of both are closely related, and technology spin-offs expected.[38]

Few people in the aerospace industry will disagree that advanced technology transferred through military programs has commercial application. In the case of the F-15 coproduction arrangement between the United States and Japan, the composites, avionics, instrumentation, and propulsion technologies transferred could be applied to civil aircraft production. Additionally, the Japanese firms could use much of the same tooling and machinery technology used to produce military aircraft to produce civil aircraft.[39]

Since 1963, MITI has directed the industrial goals and policies of Japan within the general framework of its visions reports prepared every 10 years. In 1970, when it produced its "Vision of the Future" and named aerospace one of its target industries, the Japanese people in general agreed with the concept that the country should build airplanes. Their ambitions in aircraft manufacture were no less than they were just a few years ago in the automobile, semiconductor, and steel industries.[40]

In MITI's 1980 report, it described the strategy and steps necessary for Japan to transition from its mode of technology

exploitation and product improvement to technical innovation. Military coproduction agreements represented an attempt by the Japanese government to move in that direction. To further develop its aircraft industry, Japan intended to (1) establish a consortia of Japanese aircraft manufacturers for developing and producing new aircraft; (2) enter into international joint ventures with European and American producers already established in the world market; and (3) provide government financing for aircraft R&D. Japan expected to overcome many of the obstacles it faced in developing a domestic aircraft industry through government, industry, and international cooperative approach arrangements. That Japan planned to become a major competitor in the commercial aircraft market was an open, oft-stated goal.[41]

DEFENSE PRODUCTION FOR AEROSPACE DEVELOPMENT

The Japanese government believed that the key to its commercial aircraft production rested in its military aerospace development for two reasons. First, in all countries where an aerospace industry prospered, military programs created and sustained them, not commercial markets for commercial products. Worldwide, military production remains the backbone of the industry. Of 29 jet transports built in the West, only 4 broke even financially, and Boeing Aircraft Corporation made all 4. Only recently Boeing began to profit from commercial production after 30 years of investment and military support. Second, Japan's domestic and international aerospace markets for components, sub-systems, and aircraft provided their companies the opportunity to profit

from technologies they originally developed to meet civilian needs. These "dual use" technologies (materials, micro-electronics, computers, telecommunications and other advanced technologies) are now vital to all Western aerospace industries.[42]

In the United States, which has the world's largest commercial aerospace industry, 60 percent of the output goes to the DOD and a large portion of the remainder goes to other government agencies and foreign militaries. In Japan, JDA procures more than 80 percent of the aerospace industries' output in a market where their largest producer of jet engines (Kawasaki Heavy Industries) has never sold one for commercial use.[43]

The Japanese ban on defense exports indirectly assisted the trend toward joint military projects with international partners. While the ban was not absolute, it precluded reaping significant economies of scale for aerospace production in the country. The ban also ensured the Japanese defense industries would not grow much beyond their present size based on indigenous military needs. Current Japanese policy calls for yearly self defense budgets that approximate 1 percent of the gross national product.[44]

Increases in funding for ASDF projects and procurement encouraged several Japanese firms to expand their attention to the aviation industry. As an example, Fuji Heavy Industries established a maintenance company like Lockheed's Aircraft Services Corporation. This may prove to be the springboard Fuji needs to become more involved in Asian maintenance through joint ventures with Southeast Asia countries.[45]

While Japan's share of commercial transport business is increasing, it still depends largely on military contracts. These contracts represent almost 77 percent of their aerospace procurement for Air, Ground, and Maritime Self Defense Forces. With the Cold War over, funding for military aircraft is expected to decrease by 2-3 percent annually for the next 5 years beginning in 1991.[46]

In 1989 the Japanese aerospace industry manufactured 188 aircraft, 193 engines, and employed 28,000 people. The defense sector of the industry accounted for 76 percent of its output with sales totalling $5.4 billion. Mitsubishi Heavy Industries' production of the F-15J/DJ for the ASDF comprised a large part of the production. McDonnell Douglas Corporation manufactured the first two aircraft and the Japanese assembled the next eight from kits. Kawasaki assisted as the largest subcontractor for the production. The export of civil aircraft components accounted for another 9.6 percent of the industries' output.[47]

The development of Japan's aerospace industry faced two serious handicaps. First, most of their output is for military use and they are prohibited from exporting arms. Second, the steady reevaluation of the yen made costs so high the country found it very hard to undertake a commercial project on its own.[48] Further compounding the situation was Japan's notorious inefficiency at building military aircraft and engines. Low production numbers denied economies of scale and discouraged investment in automation.[49] The increasing trend toward multinational aerospace

projects meant that Japanese-led commercial aerospace developments would eventually gain a share of defense projects in the United States and Europe. The creation of these international teams with Japanese participants was an indirect means for Japanese companies to export technology and hardware to its allies.[50] An example of this occurred with the fighter support experimental (FSX) codevelopment and coproduction venture between the United States and Japan.

THE FSX DEAL

In the past, the Japanese government purchased nearly all of its interceptor, transport, and reconnaissance aircraft from the United States or produced them in Japan under license agreements with American companies. The F-1 is the ASDF's only domestically designed and produced aircraft in its inventory. With a replacement aircraft looming on the horizon, the Japanese defense establishment, both in and out of government, believed that building the FSX in Japan would be the next logical step in developing their aircraft production technology.[51]

The FSX program involved the development of a new, advanced fighter aircraft to be used by the ASDF in the mid-to-late 1990s. Tensions in United States-Japan relations materialized over whether the aircraft would be a modified version of General Dynamics' F-16 or a new aircraft developed primarily by the Japanese. The F-16, a highly maneuverable single engine fighter, was the best American fighter designed for air combat against enemy aircraft.[52]

The Japanese government rejected the U.S. effort to sell the F-16, saying it was unsuitable to its defense needs. Japan's military manufacturers lobbied for independent development of the FSX rather than the joint development advocated by American defense contractors. They based this desire on Japan developing its own commercial and military aerospace industries to compete on the free market with the American aerospace giants. After much pressure from the DOD, JDA decided to base its design on the F-16 rather than a domestically designed aircraft.[53]

The selection of the F-16 for the FSX program resulted from a compromise dictated, in part, by political policy considerations. Privately, the government received pressure from the United States based on the huge trade imbalance with the U.S. and the technology transfer of submarine propeller milling technology by the Toshiba Corporation to the Soviet Union. Publically, the Japanese government made the choice based on cost-effectiveness, even if it meant jettisoning the original military requirements dictated by the JDA (two engines vice one).[54]

The government's desire to have a more advanced military capability, based on a newer design, swayed their decision to coproduce the FSX. To a lesser degree the element of national pride influenced the decision since the aircraft would be used for self defense. However, two other considerations were even more important in the decision process. First was the desire to be in charge of the development and production of one's own military equipment like other countries. Second was the expectation that

technology gained from the FSX development and production would have a direct spin-off to the country's civil aircraft design and production. The expectations of MITI and Mitsubishi Heavy Industries, the prime contractor, included catching up with the United States and Europe, or even taking the lead, in advanced aerodynamics, aeronautical structures, and advanced materials. The proposed Japanese avionics and radar systems for the FSX, using advanced components from the civil sector, could be as good or better than ones produced in the United States.[55]

The FSX codevelopment program represented a significant departure from the coproduction programs the United States and Japan undertook in the past. These programs differed in the types and levels of technology, know-how, and skills transferred under them. Traditionally, coproduction programs involved the transfer of production know-how, and managerial and manufacturing skills. Codevelopment differed from coproduction because it involved the transfer of design and development data, skills, and knowledge.[56]

The FSX project would allow the Japanese to take advantage of years of American R&D investment, directly benefit their aircraft development program, and substantially increase their learning curve in the aerospace business. It was not clear whether the $700,000 the Japanese government would pay for sunk U.S. R&D costs for each FSX would be comparable to the benefits to them in overall costs avoided.[57]

In 1988, the government of Japan signed a MOU with the United States government to codevelop the FSX. In doing so, it realized

the skills and knowledge acquired from the program applied to other aviation-related programs. In particular, Japanese engineers would gain valuable experience in systems integration, a process combining various aircraft components to work with each other to perform mission-related functions. With limited experience in systems integration, Japan potentially had much to gain.[58]

The original MOU contained the following provisions: (1) the FSX would be a modified version of the F-16C, incorporating the best in Japanese and American technology, and built to meet operational requirements specified by the government of Japan; (2) the ASDF would plan, manage, and fund the development of the project; (3) the prime contractor would be a Japanese firm with American companies subcontractors for the project; (4) both countries would determine the exact allocation of tasks based on cost effectiveness; (5) the United States would provide the Japanese with all applicable technical data on the F-16C; and (6) the Japanese would provide the Americans all pertinent data on derived technologies created during the development process.[59]

Through coproduction agreements, Japan acquired the technology and production expertise to manufacture aircraft, yet it still lacked the required skills to design, develop, and produce a modern jet fighter or civil aircraft. Their attempt to acquire these skills and the possible impact that may have had on the American aerospace industry led to the controversy surrounding the FSX.[60] The controversy focused on the apprehension of some groups and people in the United States concerning potential high technology

gains for Japan and led to the demise of the original FSX agreement.

Critics of the FSX deal stated the Japanese desire to develop their own aircraft industry was at the heart of their willingness to pay a higher unit cost for a codeveloped fighter aircraft. Given the expected future market for commercial aviation, it was not clear that there was a new business base for each expansion of the commercial airframe business.[61] They also believed an all-out effort by the Japanese aerospace industry to develop the aircraft posed a long-term challenge to the American domination of this key industry.

Despite opponents in industry, government, and the Congress, President Bush decided to press on with joint development of the FSX on three conditions. First, restrictions applied to release of the computer source codes for the F-16C's altitude control and weaponry control software. Second, the United States would receive the maximum share of the work during the production phase. Lastly, specific steps would insure technology derived from the project would transfer to the United States. The administration stated if the Japanese government accepted these new conditions, it could obtain approval from Congress to provide technical information on the F-16 to them. The U.S. position was that these conditions were a clarification of the original MOU while Japan viewed them as a renegotiation of the contract.[62]

Following much debate in the Senate, the FSX agreement passed on a vote of 52 to 47 with the following modifications to the

agreement: (1) General Dynamics would build one prototype and undertake 40 percent of the production, including work on spare parts that would ultimately be worth 2-3 times the initial cost of the plane; (2) the Japanese were prohibited from transferring the FSX technologies to third parties;[63] (3) the aircraft would use the Pratt & Whitney engine supplied from the United States; (4) Japan would not receive the computer source codes for the flight computer since many feared the they would use this technology to advance their commercial aircraft industry; and (5) Japan would provide the United States access to all technology involved in the project and that derived from it, including the phased array radar and composite wing structure technologies.[64]

After a 18-month delay, the FSX started in 1989, allowing a team of engineers to assemble in Nagoya, Japan to work the preliminary design. Detailed design should occur in mid-to-late 1992. About 250 engineers from Mitsubishi and its subcontractors (Kawasaki, Fuji, Shin Meiwa, and Japan Aircraft Manufacturing Company) participated in the basic design phase.[65]

From the beginning, the FSX faced a rough road. Congress almost scrapped the project; now that development is underway the aircraft faces political scrutiny in the Japanese political arena since it is 2 years behind schedule and 40 percent over cost estimates.[66]

The delay and escalating costs embarrassed the JDA. Originally the agency estimated the purchase would cost $1.21 billion, but a request by General Dynamics to set up a second,

parallel production line in Ft. Worth, Texas nearly doubled expenditures to $2.2 billion. Although Japan is building only 130 aircraft, the FSX represents their largest and most important military aircraft development program during the 1990s. Notably, it will be the only high-technology combat aircraft developed by them this century.[67]

In discussing the FSX, Yotaro Iida, president of Mitsubishi during the FSX negotiations, indicated the aircraft contract would "...be a real boost to his company from a mid-to-long term perspective. The technology Mitsubishi will accumulate during the project will go a long way towards developing future aircraft such as hypersonic and supersonic transports."[68]

A 1988 MITI report addressed Japan's need to engage in coproduction agreements of military aircraft to benefit civil aircraft development. In the future, to be competitive on the international market, "...it is undoubtedly necessary to participate as appropriate in the military sector through close contact with top Western firms. The most advanced technologies are already dual-use."[69]

The Japan Committee for Economic Development concluded that Japan's military and civil aircraft developments are linked. In a 1989 book on Politics and Productivity, the committee reported "...the Japanese aircraft industry is nurtured by the high capital cost and technological requirements of military demand that in turn established the base for an advance in civilian areas."[70]

Japanese officials see military aerospace and the FSX project in particular as the critical ingredient to developing and expanding its commercial aircraft industry. They feel the aerospace industry will revitalize their sluggish heavy industries and spread the benefits of high technology throughout the country. The Japanese believe aerospace production relates closely to the housing, machinery, leisure, automobile, and service industries, and expect it to lead and sustain the country in the twenty-first century.[71]

Without question, codeveloping the FSX will give the Japanese aerospace industry a financial and technological boost. It affords a formal structure for access to American expertise in areas where Japan lags, and it offers a generation of aerospace engineers experience on a high-performance aircraft. It also provides an avenue for an influx of capital to underwrite continued expansion of their aircraft industry--an industry where military and commercial production take place side-by-side. Codevelopment is substantially different from coproduction. It will undoubtedly advance Japan's long-range goal of competing effectively in world aerospace markets.[72]

The ISSUE OF TECHNOLOGY TRANSFER

As Japan's expertise in aircraft design and production expanded, concern grew in the United States that Japan might do to the aircraft industry what it did to the American automobile industry. The transfer of technology and design skills was an

issue for Congress and U.S. manufacturers suspicious of anything that would improve Japan's aircraft technology base.[73]

Through the transfer of process technology from U.S. coproduction agreements, Japanese companies gained the knowledge, skills, and equipment to produce modern aircraft components. The concern in United States-Japan relations was not only the issue of creating a competitor to the United States, but how Japan would use the technology it gained from American companies. The military technology had definite civil application to help them develop a civil aircraft industry.[74]

Concerns continued to surface in Washington, D.C. that Japan targeted the American aviation industry for intense development like it did with automobiles and electronics. Senator Richard Bryan (D-Nev.) told the Senate Science, Technology, and Space Subcommittee that the relative openness of the U.S. economy made it easy for the Japanese to take advantage of American research while not permitting the United States easy access to their data.[75]

Congress, to keep America's high-technology aerospace industry virtually free of competition from Japan, insisted on extraordinary restrictive measures to prevent the transfer of commercially valuable aerospace technology. This included slowing down or canceling the joint production of fighter aircraft.[76]

The technology transfer to Japan for the FSX agreement could eventually enable them to develop a military aircraft to compete against the United States for sales to third countries. To be competitive for military aircraft sales, Japan would have to

establish a significant industrial base and depart from its long-standing national policy against exporting weapon systems to other countries.[77]

The extent to which systems integration technology and skills are readily transferrable to civil aircraft development is not real clear. The General Accounting Office estimated that no individual project in the 30-year history of United States-Japanese coproduction provided Japan the technological keys to bridge the competitive gap with the United States. However, the cumulative knowledge gained from a broad range of successful joint ventures between the countries reduced the time and expense it took Japanese firms to catch up and become serious competitors in the aerospace industry.[78]

THE COMMERCIAL INDUSTRY--SMALL BUT GROWING

When the Japanese failed in the commercial aircraft market with the YS-11, they reappraised their ambitions in the civil aircraft market. They designed plans for another commercial aircraft but backed down when the losses mounted on the YS-11. In the late 1960s, Japan starkly realized it could not compete and succeed on its own in the commercial market.[79]

To more effectively compete, the government of Japan developed a strategy for its civil aircraft industry that involved: (1) forming a consortia of Japanese aircraft manufacturers for developing and producing new aircraft; (2) entering into international joint ventures with American and European manufacturers with established reputations in the world market; and

(3) providing government financing for aircraft R&D programs. Through these government, industry, and international initiatives, Japan intended to overcome many of the obstacles it faced in developing a civil aircraft industry that could successfully compete on the world market.[80]

Historically, the Japanese preferred concentrated markets to foster a worldwide competitive advantage and encourage concentration in their aerospace industry. This concentration permitted specialization, allowing each of its big three aerospace competitors--Mitsubishi Heavy Industries (MHI), Kawasaki Heavy Industries (KHI), and Ishikawajima-Harima Heavy Industries (IHI)--to secure and dominate specific market areas (e.g., MHI in aircraft structures, KHI in engines, and IHI in structural/mechanical systems). These companies reinforced their positions through teamwork that promoted specialization and eliminated duplicative efforts. Using this strategy, the Japanese accelerated their development in the industry and enhanced their status.[81]

By American standards, the stability of Japanese consortiums and the degree of collaboration were extraordinary. Prominent features of their aerospace industry included carefully orchestrated work-sharing, coordinated investment strategies, and managed competition among the top companies--all backed by extensive government support and subsidies.[82]

In Politics and Productivity: How Japan's Development Strategy Works, a study of the relationship between industrial development and defense production in Japan's aircraft industry, Richard J.

Samuels and Benjamin C. Whipple described this unique collaboration arrangement.

> The central purpose of the First Aircraft Industry Promotion Law of 1954 was to cartelize the industry with inducements to interfirm cooperation, and the law and its successors have been very successful in this regard. From the Japan Jet Engine Consortium established in July 1953 to the Orient Express hypersonic plane project now on the drawing boards, every MITI, Science and Technology Agency, and JDA program has been divided up such that the big four participate significantly in each one, regardless of which among them has been designated military prime contractor or commercial consortium leader.[83]

With the top 3 aerospace companies comprising 70 percent of the market, Japan's market structure was highly concentrated. This concentration resulted from a deliberate policy to achieve world-class capability, with each company dominating specific niches in the market. Gaining market share and expertise at the expense of profits followed their typical business philosophy. This same formula proved to be extremely successful in other industries and offered a sustainable approach in aerospace as well.[84]

Despite this ambitious approach, Japan still faced drawbacks in its independent commercial aircraft development. The limitations included the small size of its industry and domestic market, and its narrow aircraft marketing experience. To overcome these weaknesses, they hoped to join the experience and facilities of its manufacturers with those of foreign producers already established in the world market. Joint ventures appeared proper from Japan's standpoint to help its aircraft industry penetrate foreign markets.[85]

Japan's commercial participation in international joint ventures came at the initiation of private industry and MITI. With assistance from a private sector advisory body, MITI advocated joint ventures by establishing and participating in project planning with a group of several domestic aircraft manufacturers. These groups unified the ideas and coordinated the plans as a whole for each project. This strategy resulted in a consortium of three Japanese companies joining with Boeing Aircraft Corporation for the B-767 project.[86]

THE BOEING CONNECTION--JAPAN'S BIG BREAK

The Japanese used Boeing's concerns about high aircraft development costs and competition from Airbus Industries to gain experience in design and systems integration from the giant in the industry. The consortium of Japanese companies joined Boeing, with full responsibility for developing and producing fuselage components for Boeing's B-767. Unlike the F-15 and P-3C programs, where the licensee duplicated the production, this venture provided for sole production workshares of aircraft parts by each of the three partners--the United States, Japan, and Italy. Another factor that distinguished the B-767 program from previous arrangements was that the private firms worked out the details without raising policy issues for the U.S. government.[87]

The international joint venture on the B-767 marked the first time Boeing and Japanese companies joined forces for a commercial aircraft project. This signaled the beginning of a close working relationship between them. For the project, Japan Aircraft

Manufacturing Company and Shin Meiwa joined Mitsubishi, Kawasaki, and Fuji to produce the aircraft body, wing-to-body fairing, and the wing ribs. The financial arrangements called for the Japanese to receive a 15 percent share of the program.[88]

Over time, the B-767 project developed problems. Designed as a compromise to its wide-body competitor, the European Airbus A-310, the B-767 was a twin-engine aircraft with a narrower fuselage. Additionally, Boeing designed the B-767 with many expensive, high-technology features to make the airplane quieter and more fuel-efficient. Many of these features lost their appeal when oil prices plunged. Orders lagged and fell off significantly in the 1981-82 recession. For the first 7 years of the agreement, monthly production averaged 3 aircraft rather than the expected 7 or 8. When the dollar began to fall in 1985, Japan's problems compounded because the contract was fixed in dollars. Prospects improved in 1989 when orders increased to 5 aircraft per month and remained steady.[89]

The B-767 proved to be a real nugget for the Japanese. The large companies and their smaller subcontractors sent 150 engineers to Seattle, Washington for a year to work with Boeing on the design of the plane. The engineers also participated in testing, marketing, and sales support activities. The knowledge they gained meant the Japanese industry would not have to continue building aircraft through license arrangements. Japan took a major step toward becoming a force in the commercial aircraft market.[90]

To create more commercial aircraft business, a consortium of Japanese companies assumed a share in Boeing's B-777, a jumbo jet seating 285-350 passengers and designed to replace the DC-10 and L-1011 aircraft.[91] The agreement gave them a 20.8 percent non-equity stake in the airframe design and included codevelopment and coproduction in Japan. The Japanese would share in the market risk and sales financing by building a portion of the fuselage, the wing center section, the wing-to-body fairing, and the wing-in-spar ribs.[92]

Likely the B-777 will be the commercial aviation mainstay in Japan through the 1990s. Three aircraft manufacturers, Mitsubishi, Kawasaki, and Fuji, built production facilities for the B-777 as a part of the program. Unlike earlier agreements, this one specified Japanese participation in all phases of the program. The agreement also included them in marketing and sales, two areas where they admittedly needed help.[93]

In both the B-767 and B-777, Japanese companies teamed with Boeing and adapted a business strategy of collaboration. With Japan being a large market for Boeing products, Boeing decided to accept the Japanese as business partners rather than as competitors. This decision to collaborate worked to the detriment of the Europeans for the agreement closed the sale of the European-made Airbus in Japan.[94]

The collaboration also represented a new equity partnership between the United States and Japan on commercial Boeing aircraft. Under an equity partnership, both partners shared (on a percentage

basis) the up front investment of the program start-up. A MOU detailed the partnership, indicating proprietary and other rights. Under the proprietary agreements, Boeing maintained the rights to the wing design--the most critical technology in commercial aviation.[95]

U.S. critics of Boeing's relationship with Japan on the B-777 worried that America would be the loser in the end because Japanese companies would gain extremely valuable commercial aerospace technology. That Japan gained valuable technology from its deal with Boeing concerned Congress and required Boeing to soothe those concerns. But Phil Condit, Boeing's executive vice-president, admitted they could not keep Japan from gaining access to key technology. He said, "If Japan is going to be someone's partner, then Boeing wants them."[96]

Japan's publically stated strategy to establish a world aerospace industry lended credence to the fear they targeted Boeing for eclipse. Others argued that it was better to have the Japanese on the side of the United States than to have them pursue other viable options with the Europeans. According to Lawrence Clarkson, Boeing's senior vice-president for governmental affairs,

> ...Japan is a country, an economy, and a market that has to be dealt with. When you look at the French, British, Germans, and the Spanish supporting the European Airbus, I wouldn't want to see a player like Japan added to that party.[97]

Massachusetts Institute of Technology's Richard Samuels, a leading aerospace expert, said, "If there is any country in the world that

can sustain the high cost of entry into commercial aviation and do it in a strategically innovative way, it's Japan."[98]

Boeing benefitted from the deal when All Nippon Airways ordered 15 B-777s at a cost of $2.6 billion with options for 10 additional aircraft. United Airlines assisted the consortium when it ordered 34 aircraft and took options for 34 more. Boeing expects more new orders from the Far East and North America. By 1991 employment in the B-777 Division stood at 4,000 and should reach 10,000 by the end of 1992.[99]

Japan's close ties with Boeing are indicative of the growing international partnerships in the world aerospace industry. Because no company has a lock on the latest technologies, companies are constantly looking for other companies experienced in key aerospace technologies like fiber optics, avionics, and advanced production techniques--all possessed by companies in Japan. According to Boeing, Japan's objective is to be a partner with a major aerospace company. If boeing did not offer them a significant role in the B-777, then they would go elsewhere. Boeing decided it would prefer to have the Japanese as its partner than have them be Airbus' partner.[100]

Currently, Japan has several financial agreements with Boeing. For example, most of the galleys installed in commercial aircraft are made in Japan, Also, the Japanese provide some hardware and parts on a "build per drawing" basis. This means the Americans provide the design and the Japanese build to specification. These kinds of build to specification work agreements are called risk

partnerships. In a risk partnership, a return on investment is achieved only after a sufficient quantity of product is sold and profit realized.[101]

Boeing is not the only American company the Japanese are interested in. In November 1991, Mitsui & Company, one of Japan's oldest and largest trading firms, said it was considering an investment in McDonnell Douglas Corporation's civilian aircraft operation. A company spokesman said that thus far "...taking a stake in the giant American firm is only an idea."[102] MITI reported its firms are always looking to hone their skills. Buying into McDonnell Douglas would present a the firm with a golden opportunity.

McDonnell Douglas is seeking cash to finance its new MD-12 aircraft, a long-range, wide-body aircraft designed to compete with the B-747. If successful, the MD-12 would have a range of 9,000 miles, 2,000 miles more than the B-747. This new aircraft would be a winner with the Asian airlines and others flying to the Pacific, the fastest growing market in the world with some of the longest commercial legs. According to Carla A Hills, the U.S. Trade Representative, foreign investment in a company like McDonnell Douglas Corporation is a logical extension of foreign manufacturing investments which have become commonplace in the last 10 years.[103]

THE EXPANDING COMPONENTS MARKET

Japan's aircraft component industry grew concurrently with the expansion of the commercial aircraft market. Its largest aircraft engine manufacturers Kawasaki, Ishikawajima-Harima, and

Mitsubishi, did most of their manufacturing under license agreements mainly with U.S. companies. In 1971, MITI led their effort to become self-sufficient in jet engines. It concentrated on affiliating it major engine producers into an international venture with an established foreign producer. Finally in 1980, after years of trying, Japan's top three engine producers teamed with Rolls Royce to build the RJ-500 jet engine for a short-range commercial transport. Three years later the partnership grew to six when Pratt & Whitney of the United States, Motoren-und Turbinen-Union Muenchen of West Germany, and Fiat Aviagione SPA of Italy joined to form a consortium called International Aero Engines. They developed the V-2500 low-thrust engine with Japanese companies maintaining a 19.9 percent equity share in the consortium.[104]

The V-2500 experienced technical delays causing an early customer, Lufthansa German Airlines, to cancel its order. Another major setback occurred in December 1988 when All Nippon Airways, the country's second largest airline, ordered General Electric's engine for its new fleet of Airbus A-320s rather than the expected V-2500. This decision caused a shock to the aerospace industry because MITI had invested $225 million in the V-2500 project. Thus far, the V-2500 is certified for only the A-320 and the orders to date total only $2 billion from smaller airlines like Cyprus Airways and Royal Jordanian.[105]

In 1985, the U.S. National Academy of Engineering stated the principal competition from Japan in civil aviation during the next

10 to 15 years would be in supplying firms with aircraft parts and components. David Mowery supported this conclusion when he reviewed commercial ventures between the United States and Japan in his book titled Joint Ventures in the U.S. Commercial Aircraft Industry. He indicated American prime contractors were seeking to increase competition among their suppliers to reduce costs. The products offered by the Japanese should increase overall competition and help keep costs down.[106]

Japanese production of commercial aircraft engines will continue to accelerate with their participation in the design and development of the new Rolls Royce Trent 800, the Pratt & Whitney PW400, and General Electric's GE90 jet engines. MITI also plans to support the aerospace industry's expansion into the lucrative fields of aircraft equipment and systems. To date, while most collaborative efforts occurred with American firms, Japanese builders are looking to the Europeans as potential business partners. In 1990, Mitsubishi and Daimler Benz of Germany signed a cooperative agreement and Kawasaki subcontracted with British Aerospace to build fuselage parts for the Airbus A-321 transport. These ventures with foreign companies illustrate how Japan's young but growing aerospace industry has become an important supplier of aircraft components to foreign manufacturers, while at the same time earning a reputation for quality manufacture, a skilled technical work force, and on-time deliveries.[107]

JAPAN'S WORLD MARKET STATUS

Since the early 1980s, the Japan Aircraft Development Corporation (JADC) has been the mainstay for coordinating design and manufacturing in the civil aircraft industry. Funded and co-owned by Mitsubishi, Kawasaki, and Fuji, JADC's goal is to advance the development of the civil aircraft industry through research, studies, and other means.[108]

While small compared to its American and European competitors, Japan's civil aircraft industry is expanding with considerable encouragement and support from the government. It is providing funding since the extremely high development costs of new commercial aircraft make it difficult for individual aircraft companies to fund projects. These rising costs are stimulating aerospace firms to join forces and share technical expertise and the financial risks. Besides rising costs, Japan faces limitations on independent civil aircraft development because of the small size of it aircraft industry and market, and its limited aircraft marketing experience.[109]

In the early 1980s, Japan accounted for 10 percent of the world's GNP, but only 3-4 percent of the world's aircraft sales--a small percentage indicative of a fairly weak industry. But their desire to achieve major status as a developer and producer of civil aircraft has not gone unnoticed. A trade policy expert in the Office of the U.S. Trade Representative indicated "...it is essential in developing defense production projects or technology programs with Japan, that we take into account the potential

immediate and long-term impact on the Japanese civil aircraft industry and on our market position in that sector."[110]

Presently, Japan is still a minor player in the world market for commercial jet aircraft. In 1988, they exported $400 million in aircraft parts and engines for commercial jets while the total of non-communist-bloc shipments totalled $19 billion and United States exports amounted to $11 billion. Thus, Japan's share of the world market only came to about 2 percent. If military aircraft and equipment for smaller aircraft were considered, then their share of the industry would be higher. In 1988, Japan's total aircraft production reached $5.1 billion compared to an estimated $70 billion for the world market--a 7 percent share. However, $4 billion of its total went to the JDA and the rise in the yen compared to the dollar inflated the total in terms of the dollar. Adjusting for these factors, the Japanese realistically had a market share of 3-4 percent.[111]

The Aerospace Industries Association, a trade group representing 50 of the leading American aerospace manufacturers, estimated the United States imported $300 million of aerospace products from Japan in 1988 and exported $2.7 billion to them. While Japan's aerospace exports are small compared to the United States, they grew 17 percent in 1987 and 30 percent in 1988.[112] In 1989, the Japanese aerospace industry achieved the largest sales in its history when it reached $7.35 billion in total sales.[113]

Japan's strengths in the aerospace industry are growing. Their firms are close to parity with American companies in many

areas, like airborne electronics, and better in others. Japanese companies show impressive results using composites, materials made of carbon fiber that are stronger and lighter than aluminum. The United States negotiated to use the carbon-composite technology to make the airplane wings for the FSX. That technology may one day be used on commercial aircraft. According to Steve Marvin, an aviation analyst with Jardine Fleming, "The Japanese are proving themselves as low-cost, extremely reliable manufacturers of components with high quality control. The real threat is not to companies like Boeing--but to many of its suppliers in the United States."[114]

Despite these gains and the large subsidies the industry gets from the government, the Japanese commercial aircraft business is only about one-fortieth the size of its American competitors. The total value of domestic commercial aircraft production is less than 2 percent of the sales of Toyota Motors. So in spite of its persistence and flexibility, the Japanese government and the commercial sector have not replicated in commercial aviation what they did in other successful industries.[115]

FUTURE PROSPECTS FOR THE INDUSTRY

Japan plans to increase and strengthen its role and participation in new joint ventures and to expand its own aircraft R&D efforts to increase its share of the world market. Their renown quality workmanship, production skills, and increasing technology base should offer them a greater inroad to partnerships with foreign companies.[116] Many U.S. government and aerospace

industry analysts believe Japan will become a serious competitor in the world aircraft market like it did in the automobile industry. The only real questions are when and how much of a share it will command.[117]

The most notable aspect of Japan's aerospace industry is its future potential rather than its past achievement. It may realize that potential as a result of several cooperative arrangements. Increasingly, multinational projects typify Japan's aviation industry, especially in commercial aviation where the market will significantly expand in the next few years. [118]

In 1989, Boeing estimated the world aircraft market for new airplanes over the next 15 years would average $38 billion yearly compared to $14 billion from 1970-1989. Over the next decade, the industry will scrap 300 aircraft each year compared with only 47 in 1989. But meeting the great demand is not without risks. It costs approximately $2-4 billion to launch a new-generation aircraft and it takes sales of almost 600 aircraft to break even over a period as long as 14 years. Development costs for a new engine run $1-1.5 billion and require sales of 2000 engines over about 10 years to break even. With astronomical costs like these, it is little wonder the Japanese can ill afford to go it alone in areas where they lack all-around expertise. The future market almost demands companies share the risks via international alliances to effectively compete.[119] As executives at Boeing and other companies view the situation, the United States should take advantage of Japan's determination to get into aerospace.

Alliances make and save money, and U.S. companies are some of the main partners of choice.

In the aerospace industry the Japanese are seeking technology leadership rather than cost leadership. An analysis by Booz-Allen & Hamilton, a New York management and consultant firm, said the Japanese will emerge as leaders in certain segments of the industry far faster than expected. It reported that Japanese firms "...have created innovative solutions to major design problems and demonstrate consistently shorter development times and more flexible product designs than their U.S. competitors."[120] As a result of the report, Booz-Allen anticipates the Japanese aerospace industry will grow from $7.35 billion in 1989 to $25-30 billion by 2000.[121]

Domestically, Japan's needs and a shrinking JDA budget will not meet the growth needs of the top three aircraft manufacturers and their subcontractors. Most likely, these companies will continue to seek business in the international arena--especially in the joint collaborative area. According to Eiichi Ono, president of the Society of Japanese Aerospace Companies, "Japan's share of international projects is increasing with this trend expected to continue. Japan still lacks experience in the key areas of aerospace project and system coordinator."[122]

Overall though, Japan's future prospects in the commercial aviation industry look good. While their current share of the market is small, there are definite signs that the commercial business will begin to grow. In the V-2500 and B-767 programs,

plus many subcontracting jobs done for Boeing and McDonnell Douglas, they established a reputation for manufacturing high quality aircraft components. This work, coupled with the many military coproduction projects over the past 35 years, allowed the Japanese to build a large infrastructure of more than 200 companies that regularly make components for the aerospace industry. With the emphasis on advanced electronics, high-value-added manufacturing, composite materials, and miniaturization, Japanese corporations in many industries are poised to provide the advanced technologies that will go into the aircraft of the future.[123]

While the country's ultimate goal is for made-in-Japan airliners to fly all over the globe, they continue to pursue more modest goals. According to a Baring Securities report, Japan's civil aerospace producers are preparing to launch an assault on the world's components and subcomponents markets. Industry experts expect them to penetrate the component market in aircraft engines advanced materials, structural components, and avionics.[124]

Japan's ratio of military aircraft production to civil aircraft production should favor the civil side as it enters into international ventures in civil aircraft and engines. A case in point is the substantial civil aircraft activity resulting from the B-767 joint development and production program. Unlike the F-15 and P-3C coproduction programs, the B-767 agreement provided for sole production workshares of aircraft parts by companies from the United States, Italy, and Japan.[125]

In the military arena, Japanese competition may emerge in the lucrative military arms sales. The current Japanese ban on exporting military technologies (except exports to the United States under flow-back agreements like the FSX) is merely government policy; it is not in the constitution and thus can change. More than likely, the definition of dual-use technologies, those technologies that can be used for either civil or military purposes, will expand. In recent years, Japanese manufacturers sold helicopters to Burma, Saudi Arabia, and Sweden, and transport aircraft to Zaire. The technology flow-back arrangement on the FSX will undoubtedly cause some unrest in the United States.[126]

Two other aircraft development programs follow the FSX--the OHX and ATX. The OHX will replace the OH-6D helicopter in service with the Ground SDF. Mitsubishi, Kawasaki, and Ishikawajima-Harima are after the powerplant contract. Like other acquisitions, JDA wants the manufacturers to form separate consortiums to build the airframe and engine. Many analysts expect the United States government to pressure Japan for an American firm to participate in the helicopter program like General Dynamics did with the FSX. Estimates call for the government of Japan to buy 130-150 OHXs by the end of the 1990s.[127]

The ATX will replace the 90 Mitsubishi T-2 advanced trainers operated by the ASDF. While no official decision has been made, JDA expects Mitsubishi, Kawasaki, and Fuji to compete for the contract. Financing appears to be the greatest obstacle facing the development costs considering the escalating FSX program estimates.

An alternative is to develop a supersonic version of the Kawasaki T-4 subsonic intermediate trainer used by the ASDF.[128]

In addition to producing a domestic military aircraft, the Japanese still intend to pursue a domestically produced commercial aircraft. The JADC is looking at a follow-on aircraft for the commercially unsuccessful YS-11. Tentatively called the YSX, the aircraft would be a twin engine jet designed for a regional market.[129] MITI appears ready to subsidize the program similar to the way it did the B-777. The Japanese government invited British, French, and Chinese companies to join Kawasaki in this regional transport program. Cost is a key concern. According to executives in the Society of Japanese Aerospace Companies, the program will not proceed if development costs exceed $370 million.[130]

The potential success of this aircraft is questionable since it would have to compete with the B-777 at the lower end of the trunk market for flights hauling 100- 130 passengers. In addition, for those routes serviced by aircraft transporting 50-90 passengers, the YSX would have to compete in a market dominated by turboprops.[131]

In addition to the YSX, the aerospace industry continues to look at future technologies. Mitsubishi, Kawasaki, and Fuji teamed up with two domestic automakers and asked to join the international group, led by Boeing, to study the feasibility for a follow-up aircraft to the British/French Concorde. Boeing believes a very high speed aircraft flying at Mach 2.0-2.5 with 250-300 passengers

and with a minimum range of 5000 miles offers the best opportunity to meet the economic and environmental objectives.[132] This study dovetails with a 7-year $520 million program funded by MITI. MITI wants to develop advanced, high-heat resistant composite materials and research into supersonic transport propulsion systems.[133] The results of the study should be out in 1992.

In the fall of 1991, the Japanese government gave its prime aircraft engine project to a consortium of American, British, and French participants when MITI announced these countries joined a Japanese-led project for a supersonic/hypersonic propulsion engine. The engine will power an aircraft flying 3-5 times the speed of sound that is two generations beyond the world's only supersonic airliner. Pratt & Whitney, General Electric, Rolls Royce, and Snecma will get about 25 percent of the development work using Japanese government funds while Mitsubishi, Kawasaki, and Ishikawajima-Harima, will receive the rest.[134] All told, the Japanese will invest approximately $219 million over a 7-year period for the engine development project.[135]

Based on Japan's inroads on the B-767, B-777, the V-2500 engine, and many R&D projects (to include the SST research and supersonic/hypersonic engine), U.S. Department of Commerce aerospace experts expect the Japanese will be a major force in the industry. Industry analysts predict their emergence will begin at the low end of the market and in market niches. They will then move up the ladder by providing subcomponents, components, and then parts. While not a threat to Boeing or McDonnell Douglas in the

next 15 years, Japan may attain a major presence in the world helicopter market based on its proven production skills, quality workmanship, and strong desire to succeed.[136]

CONCLUSION

As the figures show, the Japanese have thus far failed to capture a sizeable share of the world's commercial aviation market. Despite a series of setbacks, they remain convinced they can compete successfully in the market and ultimately gain a larger share. Their strategy encourages the accumulation of a wide range of technologies necessary to the aerospace industry through defense expenditures and other government programs. They also intend to enter select international programs with American and European companies to promote and advance the aerospace industry. The Japanese are committed to this strategy for it is how they see their economic future.[137]

The Japanese will continue to expand their aerospace technology, especially in sensors and electronics-dominated subsystems, because these fields are extremely dependent upon micro-electronics, an area in which they are the world's leader. With an emphasis on quality and international marketing capability, Japan will likely gain a larger share of the world aerospace market if it can tailor its aerospace products to the needs of the international customer like it has other successful consumer products.[138]

The strong momentum of the Japanese aerospace industry should have an enormous long-term impact on the world market and aerospace

technology. It is clear they are players to be reckoned with in the industry; one can view their expanding role in aerospace manufacturing as either a threat or an opportunity. In view of this development and the fragmented nature of the industry, it would behoove American firms to move swiftly to frame a continuing partnership approach with the Japanese as a response to Japan's involvement in the world aerospace market.[139]

The Japanese intend to play a key role in the commercial aviation business beyond supplying high-quality components to large foreign corporations. It is hard to imagine their proven manufacturing skills, financial situation, strong commitment, and ability to integrate huge projects will not make them the next large force to contend with in this extremely competitive industry. How they will do this remains to be seen. It may occur through a commercial aircraft joint venture with a large international partner, a breakthrough technological advancement in supersonic or hypersonic flight, a buyout of a financially strapped foreign aerospace company, or any of several other logical possibilities. Regardless of how it occurs, Japan will patiently wait for the right opportunity to reach its goal of becoming a premier aircraft manufacturer for the world market.[140]

ENDNOTES

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