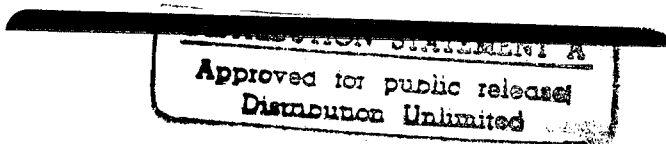


TROUBLED PARTNERSHIP

A History of U.S.-Japan
Collaboration on the
FS-X Fighter



Mark Lorell

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Project AIR FORCE

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PREFACE

This book presents a detailed account of the history of U.S.-Japan cooperative development of the FS-X fighter from the origins of the program through 1993. It focuses on issues of technology transfer and the long-term implications of cooperative development programs for the American aerospace industry and U.S. security policy. It is meant to be read in conjunction with a companion document (Lorell, 1995), which synthesizes the key findings and recommendations of the larger document.

This book emerged from a RAND research project conducted in the early 1990s on collaboration with Asian allies on military aircraft R&D. The Resource Management and System Acquisition Program of RAND's Project AIR FORCE initiated this research, which was sponsored by the United States Air Force.

This book and its companion document are intended to assist U.S. government officials in formulating better policies and strategies for effective military technology collaboration with Japan and other allies. They should also be of interest to the general reader who is concerned with U.S. industrial competitiveness and maintaining America's preeminence in defense R&D.

The views expressed in this book are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. government.

PROJECT AIR FORCE

Project AIR FORCE, a division of RAND, is the Air Force federally funded research and development center (FFRDC) for studies and analyses. It provides the Air Force with independent analyses of policy alternatives affecting the development, employment,

combat readiness, and support of current and future aerospace forces. Research is being performed in three programs: Strategy, Doctrine, and Force Structure; Force Modernization and Employment; and Resource Management and System Acquisition.

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SUMMARY

For various reasons, the United States has generally tried to discourage its allies from developing their own major weapon systems. Perhaps the most prominent example of this policy was America's insistence on cooperative development in the case of Japan's FS-X fighter aircraft. Did the outcome of the divisive struggle over the FS-X serve U.S. aims? What can be learned for future interaction on the FS-X program in particular and cooperative development in general? The research documented in this book sought to answer these questions.

CONFLICT AND COMPROMISE

In the summer of 1985, senior U.S. government officials began efforts to reverse Japan's decision to develop independently its first world-class fighter since World War II. They urged Japan to join the United States in the cooperative development of a modified version of an existing U.S. fighter. In doing so, DoD hoped to promote weapon system interoperability and to avoid the diversion of scarce Japanese defense resources from efficiently supporting the security alliance with the United States. U.S. officials also wanted to forestall the emergence of an independent Japanese defense industrial capability that could contribute to a more autonomous security policy.

After several years of difficult negotiations, Japan agreed to cooperatively develop a modified General Dynamics (now Lockheed) F-16. Despite Japanese concessions, however, submission of the agreement to Congress in early 1989 led to a long, acrimonious debate, driven mainly by economic concerns over technology transfer and U.S. industrial competitiveness. Critics in Congress and elsewhere believed that the FS-X represented a "giveaway" of advanced

aerospace technology to America's most relentless economic rival, with few guarantees of anything significant in return. Ultimately, the domestic debate forced the Bush administration to insist on further clarifications to the agreement, causing considerable anger and frustration in Japan.

Actual R&D for the FS-X fighter did not get under way until April 1990, nearly a year and a half after the signing of the original agreements and almost five years after the start of the original negotiations. Since then, U.S. policymakers have focused on guaranteeing access and flowback of Japanese technology. Meanwhile, extensive changes to the baseline F-16 design have been quietly carried out in Japan.

A MIXED OUTCOME

Despite years of haggling and stacks of signed agreements, the FS-X program is not meeting many of the initial expectations the Pentagon negotiators had when it was agreed to in 1987. Most important, the aircraft has evolved away from the original concept of a minimally modified F-16 to a virtually all-new Japanese-developed fighter broadly based on the F-16. As a result, the FS-X is providing Japanese industry with an entrée into the highly exclusive world club of developers of advanced fighter aircraft, a development with long-term implications for the U.S. military aerospace industry and for U.S. security policy. The FS-X will do little to promote the development of a commercial aircraft industry in Japan, but it will greatly increase Japanese military R&D capabilities. How did this happen? The research points to five key U.S. policy errors:

- *The U.S. government did not formulate and implement a single, coordinated strategy toward collaboration with Japan that harmonized both U.S. military and economic objectives. U.S. security and economic objectives differed and sometimes conflicted. While the U.S. security establishment concentrated on stopping Japanese indigenous development by transferring all the necessary F-16 technical data packages to Japanese industry, Congress and the Department of Commerce sought to restrict this technology transfer, thus promoting greater Japanese indigenous development.*

- *The American side pressured the Japanese political leadership to accept a type of cooperative development program that was strongly opposed by the Japanese military R&D establishment.* This made genuine sharing of technology and expertise based on a perception of mutual benefit unlikely. The U.S. side sought a cooperatively developed FS-X based on a minimally modified F-16C; the Japanese R&D establishment sought to develop an all-new national fighter based on a Japanese design and Japanese technology. Forced to cooperate with the Americans, they formulated and implemented a counterstrategy aimed at maximizing modifications to the baseline F-16, while minimizing U.S. control over the technical evolution of the R&D effort.
- *The FS-X program should have been structured to provide greater U.S. influence over the final design configuration and technological evolution of the aircraft.* The U.S. side could have followed one of two options: It could have pushed harder on the political level for licensed production of a U.S. aircraft, or it could have structured a more genuinely collaborative joint R&D program that included significant U.S. government funding and specific design and technology objectives meant to contribute to U.S. weapon systems.
- *The U.S. government underestimated Japan's military R&D capabilities.* This contributed to the failure of the Americans to control the technical evolution of the FS-X and encouraged U.S. skepticism about the potential value to the United States of Japanese defense-related technology.
- *U.S. policy on technology transfer and access was fundamentally flawed.* U.S. critics misunderstood the central motivation behind the FS-X in Japan and grossly overestimated the potential commercial value to Japanese industry of U.S. defense technology. This preoccupation caused constant disputes and diverted attention away from the Japanese strategy to transform the FS-X.

WHERE TO GO FROM HERE

Now that R&D is nearly complete, ensuring full series production of the FS-X is of critical importance for the United States. The

bulk of the potential economic, technological, and political benefits to the United States depends on series production. Therefore, U.S. officials should adopt a flexible approach toward questions of work-share, technology transfer, and access to Japanese technology during negotiations for a production agreement. Although cancellation is unlikely, it would be the worst outcome from the U.S. point of view, particularly since the Japanese would in all likelihood go ahead and develop an all-national next-generation fighter.

Perhaps the most important lesson of the FS-X is that the U.S. government needs to formulate and implement a single, coordinated policy on weapon system procurement collaboration that harmonizes U.S. military and economic objectives. This policy should recognize that two-way technology transfer in codevelopment arrangements works best when industry on each side expects significant net technological gain. In such cases, both participants will make technological and financial contributions to the joint effort that complement each other and directly assist each side in achieving its own objectives.

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From 1992 through 1994, the author conducted extensive interviews with scores of current and former U.S. government officials directly involved in the FS-X program. These included representatives from various U.S. Air Force offices, Air Force and Navy R&D laboratories, Air Force liaison offices in Japanese Industry and the Japan Defense Agency, the Office of the Secretary of Defense, the Defense Security Assistance Agency, the Defense Technology Security Administration, the Department of Commerce, the Department of State, the U.S. Embassy in Tokyo, the Mutual Defense Assistance Office, the U.S. General Accounting Office, and the Office of Technology Assessment. On the U.S. industry side, numerous managers and engineers at Lockheed Fort Worth and Lockheed Nagoya (formerly General Dynamics), General Electric engines, and Westinghouse were interviewed. Related interviews were conducted with representatives of Boeing and McDonnell-Douglas.

To gain a better understanding of Japanese government policies, the author interviewed many officials at the Japan Defense Agency Policy and Equipment Bureaus, the Air Self-Defense Force Air Staff Office, the Technical Research and Development Institute, the Ministry of International Trade and Industry, the Ministry of Foreign Affairs, and the Defense Research Center. Industry views were sought through extensive discussions with managers and engineers at Mitsubishi Heavy Industries, Kawasaki Heavy Industries, Fuji Heavy Industries, and Mitsubishi Electronics Corporation.

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ABBREVIATIONS

AEW	Airborne early warning
AFTI	Advanced Fighter Technology Integration
AIA	Aerospace Industries Association
AIS	Avionics Intermediate Shop
AMRAAM	Advanced Medium-Range Air-to-Air Missile
APA	Active phased array
APC	Armored personnel carrier
ASDF	Japanese Air Self-Defense Force
ASO	Air Staff Office (JDA)
ATA	Advanced Tactical Aircraft
ATF	Advanced Tactical Fighter
AWAC	Airborne warning and control
BMI	Bismaleimides
CCD	Charge coupled devices
CCV	Control configured vehicle
CFC	Carbon-fiber composites
CRS	Congressional Research Service
dem/val	Demonstration and validation
DoC	Department of Commerce
DoD	Department of Defense
DSAA	Defense Security Assistance Agency
DSB	Defense Science Board
DTSA	Defense Technology Security Administration

EFA	European Fighter Aircraft
EW	Electronic warfare
FBIS-EAS	Foreign Broadcast Information Service—East Asia Daily Report
FBW	Fly-by-wire
FET	Field effect transistor
FHI	Fuji Heavy Industries
FSET	Fighter Support Engineering Team
FS-X	Fighter Support-Experimental
GaAs	Gallium arsenide
GAO	General Accounting Office
GD	General Dynamics
GSDF	Ground Self-Defense Force
HUD	Head-up display
HF	High frequency
IA	Implementing agreement
IEWS	Integrated Electronic Warfare System
IFF	Identification friend or foe
IHI	Ishikawajima Harima Heavy Industries
INS	Inertial navigation system
IR	Infrared
IRS	Inertial reference system
JAEI	Japan Aviation Electronics Industries
JDA	Japanese Defense Agency
JMTC	Joint Military Technology Commission
JPRS-JST	Joint Publications Research Service—Japan Science and Technology
KHI	Kawasaki Heavy Industries
LAN	Local area network
LDP	Liberal Democratic Party

LTA	License and Technical Assistance Agreement
LFWC	Lockheed Fort Worth Company
LTV	Ling Temco Vought
MBB	Messerschmitt-Bölkow-Blohm
MBT	Main battle tank
MC	Mission computer
MDAO	Mutual Defense Assistance Office
MELCO	Mitsubishi Electronics Corporation
MHI	Mitsubishi Heavy Industries
MITI	Ministry of International Trade and Industry
MMIC	Monolithic microwave integrated circuits
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
MOIA	Memorandum of Implementation and Agreement
MoU	Memorandum of Understanding
MRC	Mitsubishi Rayon Corporation
MSDF	Maritime Self-Defense Force
NAL	National Aerospace Laboratory
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDPO	National Defense Program Outline
NEC	Nippon Electronics Company
NRL	U.S. Naval Research Laboratory
NSC	National Security Council
OSD	Office of the Secretary of Defense
OUSDRE	Office of the Under Secretary of Defense for Research and Engineering
PA&E	Program Analysis and Evaluation
RAM	Radar-absorbing material
R&D	Research and development

RFP	Request for Proposal
RSI	Rationalization, standardization, and interoperability
SAM	Surface-to-air missile
SASC	Senate Armed Services Committee
SDI	Strategic Defense Initiative
SDF	Self-Defense Forces
SLEP	Service-Life Extension Program
SMS	Stores Management System
SPO	System Program Office
S&TF	Science and Technology Forum
STS	Software test station
STOL	Short takeoff and landing
TAT	Technology Assessment Team
TDP	Technical data package
TI	Texas Instruments
TKF	<i>Taktisches Kampflugzeug</i> (German tactical combat aircraft)
TOGW	Takeoff gross weight
T/R	Transmit and receive
TRDI	Technical Research and Development Institute
TSC	Technical Steering Committee
TTP	Technology Transfer Procedures annex
UN	United Nations
USDRE	Under Secretary of Defense for Research and Engineering
USTR	U.S. Trade Representative
VHSIC	Very high speed integrated circuits

INTRODUCTION

BACKGROUND

In the summer of 1945, the once proud Japanese military aircraft industry lay in ruins, destroyed by legions of heavy American bombers. The few remaining Mitsubishi "Zero-Sen" fighters, the terror of Allied fighter pilots in the Pacific in the early years of the war, stood helpless on the ground because of lack of fuel.

Until well into the Korean War, the American occupation forces prohibited Japanese industry from developing and building military aircraft. But a handful of industrialists and military officers continued to dream of the day when Japanese fighter aircraft would again be respected and admired the world over. Although the Americans eventually encouraged Japanese industry to manufacture U.S. fighters under license, plans for a new "Rising Sun fighter" (*hi-no-maru*) designed and developed entirely in Japan remained stymied by various economic, technological, and political factors.

By the mid-1970s, however, the economic and technological balance in the Pacific began to shift in Japan's favor. A small group of Japanese politicians, industrialists, and generals believed the time had finally come to develop a world-class indigenous fighter, code-named Fighter Support-Experimental (FS-X), which could take its place as the modern Zero of the postwar era. After much planning and effort, this group eventually convinced Japan's political leadership to support indigenous development of a national fighter.

Distracted by growing economic and trade disputes with Japan, and with the American military focused on the Soviet threat, se-

nior U.S. policymakers remained largely unconcerned with these developments until mid-1985. At that time, America's premier fighter aircraft companies, concerned about the prospect of competition from a resurrected Japanese military aircraft industry, voiced their concerns to the Pentagon and Congress.

By the summer of 1985, the Pentagon had moved into action to stop the FS-X Rising Sun fighter. After three years of difficult negotiations, the two sides wrapped up the final terms of a compromise deal, whereby America and Japan agreed to develop the FS-X together based on a "minimally modified" Lockheed (formerly General Dynamics [GD]) F-16C. This deal, it was hoped, would enhance the important security relationship between the two countries, contribute to greater U.S.-Japan defense technology cooperation, and further inhibit the emergence of a more autonomous Japanese military aircraft industry that might threaten the fragile strategic balance in the western Pacific and pose a commercial threat to American military aircraft companies.

But in early 1989, the FS-X cooperative arrangement became the center of debate in Congress. Concerned about technology transfer and the trade deficit, many in Congress and elsewhere viewed the deal as a high-technology "giveaway" to America's most fearsome economic competitor. Critics feared that Japan wanted American fighter-aircraft technology to help develop a commercial aircraft industry that would compete with Boeing and McDonnell-Douglas airliners. The FS-X issue grew into a major domestic political battle during the first months of the Bush administration and eventually mushroomed into one of the most serious trade and technology disputes with Japan since 1945.

Since 1989, the FS-X controversy has faded from the headlines. In many respects, the FS-X effort has evolved into a model program for defense technology cooperation between the two allies. But the changes driven by the 1989 debate in Congress unintentionally contributed to the ability of Japanese industry and the military research and development (R&D) establishment to salvage many of the original technology goals planned for indigenous fighter development within the context of the new cooperation program.

In the fall of 1995, a half-century after the surrender of the Imperial Japanese Government, the first FS-X fighter prototype is scheduled to take to the air near Mitsubishi's modern facilities in Nagoya, close to where the Zero fighter had once been manufac-

tured. Instead of the minimally modified U.S. fighter originally intended by the Pentagon, the FS-X will be so radically changed as to constitute a virtually all-new world-class aircraft developed largely by Japanese industry. Japan will have entered the elite ranks of the handful of nations that can develop advanced high-performance fighter aircraft. As a senior Japanese general proudly proclaimed at the unveiling of the full-scale mock-up of the FS-X in 1992, "This will be the Zero fighter of the modern era."¹

How and why did the FS-X program evolve away from the original Pentagon conception of a minimally modified American fighter toward something that approximates the indigenous national fighter that the Japanese had sought all along? Why did the United States fight so hard to limit Japanese access to its technology, when the result encouraged Japan to engage in more indigenous development? And why did the United States cause considerable friction with its partner by insisting on gaining access to Japanese technology in which U.S. industry had little genuine interest?

This study presents a detailed history of the FS-X program that helps answer the question of *how* the FS-X evolved away from the direction the United States was striving for at the beginning of the program. A brief companion volume (Lorell, 1995) summarizes the answers to the question of *why* the evolution occurred, but all the threads for that analysis are present here in the historical volume. In a nutshell, these threads point to problems with differing and sometimes conflicting economic and security objectives advanced by different interests within the U.S. government; an overemphasis on technology reciprocity and other narrow economic issues at the expense of important security objectives; and poor coordination, management, and implementation of some aspects of the program negotiations and implementation.

OVERVIEW: WHAT WENT WRONG?

The FS-X program has proven to be a long and difficult experiment in international collaboration for both the United States and Japan. Beginning with the tentative approval by the Japanese government for launching an indigenous fighter development pro-

¹General Kiyoshi Matsumiya, quoted in "Zero of the '90s" (1992), p. 1.

gram in mid-1985, it took nearly five years of difficult negotiations, occasionally punctuated by bitter disputes, before the two sides actually began a cooperative R&D effort in March 1990. In addition, a long series of formal agreements and additional clarifying agreements, some of which took years to negotiate, were necessary before all the terms of the deal were finally established. Yet, ten years after the initial negotiations, important issues and questions still remained unresolved. Some of the most important of the formal FS-X agreements are shown on the timeline in Figure 1.1.

Despite years of haggling and stacks of signed agreements, the FS-X program is not meeting many of the initial expectations of the Pentagon negotiators when the program was agreed to in 1987. The single most important shortfall of the program is that it has evolved away from the original Pentagon concept of a minimally modified F-16 to a virtually all-new Japanese-developed fighter broadly based on the F-16.

Why is this important? FS-X is providing Japanese industry with an entrée into the highly exclusive world club of developers of advanced fighter aircraft weapon systems, one of the most potent conventional weapons in existence. This has potentially major long-term implications for the U.S. military aerospace industry and

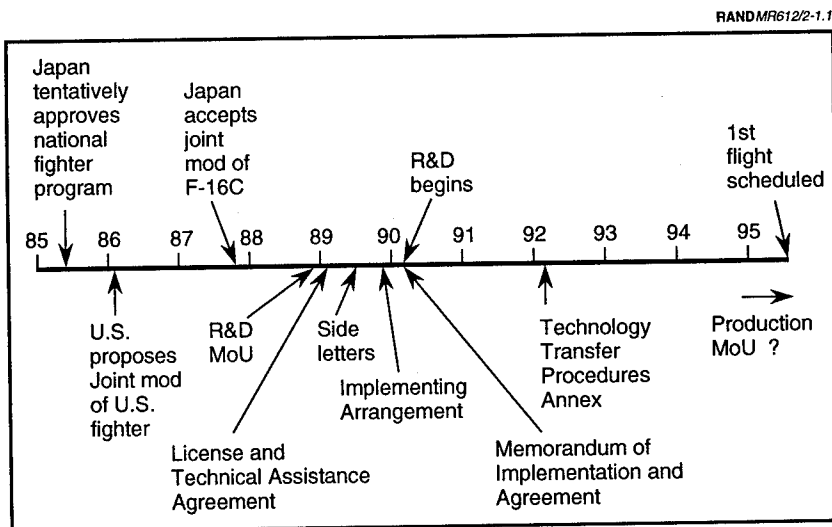


Figure 1.1—Timeline of FS-X Agreements

for U.S. security policy. FS-X is doing relatively little to help Japanese industry become more competitive in the commercial airliner business. But it is contributing significantly to improving the capabilities of Japanese industry to design, develop, and produce its own advanced military combat aircraft.

A careful and detailed review of the history of the program indicates at least five general problem areas and policy errors for the United States that caused the FS-X R&D program to produce only mixed results and led to many of the disputes and difficulties that have plagued the joint effort:

- *The U.S. government did not formulate and implement a single coordinated strategy toward collaboration with Japan that harmonized both U.S. military and economic objectives.* U.S. security and economic objectives differed and sometimes conflicted. The U.S. overemphasis on questionable issues related to general economic frictions with Japan and to technology transfer directly contributed to the success of the Japanese strategy to transform the FS-X.
- *The American side pressured the Japanese political leadership to accept a type of cooperative development program that was strongly opposed by the Japanese military R&D establishment.* This made genuine sharing of technology and expertise based on a perception of mutual benefit unlikely. The U.S. side sought a cooperatively developed FS-X based on a minimally modified F-16C; the Japanese R&D establishment sought to develop an all-new national fighter based on a Japanese design and Japanese technology. Forced to cooperate with the Americans, they formulated and implemented a counterstrategy aimed at maximizing modifications to the baseline F-16, while minimizing U.S. control over the technical evolution of the R&D effort.
- *The FS-X program should have been structured to provide greater U.S. influence over the final design configuration and technological evolution of the aircraft.* The U.S. side could have followed one of two options. It could have pushed much harder on the political level, which was more amenable to U.S. influence, for licensed production of a U.S. aircraft by Japan. However, this strategy entailed some risk that Japan might reject

the U.S. position and move ahead with indigenous development. Alternatively, the U.S. side could have structured a more genuinely collaborative joint R&D program that included significant U.S. government funding and specific U.S. design and technology objectives meant to contribute to U.S. weapon systems. This could have provided far more U.S. leverage to influence the technological evolution of the FS-X.

- *The U.S. government underestimated Japan's military R&D capabilities.* This contributed to the failure of the American side to control the technical evolution of the FS-X and encouraged skepticism in the U.S. defense industry and the security establishment regarding the potential value to the United States of Japanese defense-related technology.
- *U.S. policy on technology transfer and access was fundamentally flawed.* U.S. critics misunderstood the central motivation behind FS-X in Japan and grossly overestimated the potential commercial value to Japanese industry of U.S. defense technology. The U.S. emphasis on access to Japanese technology was largely political symbolism to appease critics in Congress and elsewhere. This emphasis caused constant disputes, and diverted attention away from the Japanese strategy to transform FS-X.

Now that R&D is nearly complete, ensuring full series production of the FS-X is of critical importance for the United States. The bulk of the potential economic, technological, and political benefits to the United States depends on series production. Therefore, U.S. officials should adopt a flexible approach toward questions of work-share, technology transfer, and access to Japanese technology during negotiations for a production agreement. Although cancellation is unlikely, it would be the worst outcome from the U.S. point of view, particularly since the Japanese would in all likelihood go ahead and develop an all-national next-generation fighter.

Successful defense technology collaboration with Japan in the future will depend on an understanding of the mistakes of the past. As one senior Japanese defense expert wryly noted: "It [the FS-X program] will be a success if we never repeat it again!"² It is hoped

²Statement by Tetsuo Tamama of the Japan Defense Research Council at the U.S./Japan Economic Agenda's Conference on High Technology Policy-Making in

that this document, by providing a detailed policy history of the program, will make a significant contribution to better understanding what went wrong on FS-X.

ORGANIZATION OF THIS DOCUMENT

Chapters Two, Three, and Four present some necessary context for understanding the FS-X collaborative program by providing a historical perspective on the persistent tensions between Japan and the United States over defense technology transfer, as well as the emergence of a more capable Japanese military aircraft sector. Specifically, Chapter Two focuses on the fundamental shift in the U.S.-Japan global power relationship that began in the mid-1970s and examines the frustrating and largely unsuccessful attempts by the Pentagon beginning in 1979 to gain greater access to Japanese defense-related technology as a means of compensating for the military aerospace technology transferred to Japan over the previous decades through the licensed production of U.S. fighters.

Chapters Three and Four recount the postwar history of the Japanese fighter aircraft industry, showing that, by the mid-1980s, Japanese industry and military leaders had finally convinced the government to go ahead with indigenous development of a world-class fighter. They also explain how, with limited resources, Japanese industry and the military built up the basic industrial and technological capabilities necessary to develop a national fighter through a clever strategy of combining American technology gained through licensed production, Japanese dual-use technology developed for the commercial sector, and targeted military R&D programs.

Chapters Five through Eleven detail the key events in the FS-X program, following the path shown in the timeline in Figure 1.1. The initial U.S. attempts to stop development of a Japanese indigenous fighter beginning in 1985 by convincing Japan to license-produce or slightly modify an existing U.S. fighter are discussed in Chapter Five.

Chapter Six examines the counteroffensive launched by the supporters of indigenous development in Japan against the Pen-

tagon position, while the long and difficult negotiations in 1988 over how to structure the joint program are discussed in Chapter Seven. Chapters Eight and Nine recount the debate in Congress about the FS-X deal in the early days of the Bush administration and its aftermath. Chapter Ten shows how, under cover of the public controversy in the United States and the increased American emphasis on technology transfer and access, the Japanese were able to successfully transform a minimally modified U.S. F-16 aircraft into something approaching a virtually all-new Rising Sun fighter. Chapter Eleven examines the initial struggles on the U.S. side to gain access to the FS-X technology during the early phases of the R&D effort.

Chapters Twelve and Thirteen take a step back from the history and provide an overview of the FS-X program and of collaborative weapon development efforts in general. Chapter Twelve reviews the balance of technology transfer as of the end of 1993 and some of the economic benefits to the United States; it then turns to the more important long-term technological benefits to the Japanese defense industry. The final chapter builds off the insights in Chapter Twelve, identifying some of the problems that drove the program away from the direction American officials originally intended, presenting some lessons learned about collaborative development programs, and discussing the issue of how collaborative development programs affect the proliferation of military R&D.

**THE U.S. QUEST FOR TECHNOLOGY
RECIPROCITY**

INTRODUCTION

In the late 1970s, the Pentagon became increasingly interested in acquiring advanced Japanese dual-use technologies that could be used in manufacturing and developing new American weapon systems. This interest was motivated both by Japan's emergence as a world technological leader in electronics and other fields and by the growing political necessity in the United States of balancing the flow of American defense technology to Japan with a reciprocal flow of Japanese technology to the United States.

Well before FS-X became a concern in 1985, the Pentagon launched a series of technology initiatives aimed at Japan. From 1985 through 1987, the period during which the FS-X negotiations focused primarily on the question of whether Japan should develop its new fighter on a national basis or in cooperation with the United States, the problem of technology reciprocity remained in the background. However, by 1989, congressional and Department of Commerce (DoC) concern helped move the issue into the foreground of the FS-X negotiations. Subsequently, technology transfer and the question of technology reciprocity became a primary cause of ongoing frictions and disputes in the early phases of cooperative FS-X R&D.

A recounting of the Department of Defense (DoD) technology initiatives predating FS-X is illuminating for several reasons. First, it shows that the legalistic, essentially ad hoc, and largely symbolic approach the Pentagon later adopted toward acquiring

Japanese technology during the initial phases of the FS-X program directly mirrored the earlier, more general U.S. technology initiatives of the late 1970s and early 1980s. In both periods, the U.S. side first sought a broad legal framework for access to Japanese technology, while paying insufficient attention to the formulation of realistic and practical mechanisms for its actual transfer. This approach suggests that the U.S. initiatives were sought largely for the political symbolism of Japan agreeing to the principle of greater reciprocity in the flow of technology. In both cases, Pentagon efforts to determine whether the American military services or U.S. defense industries were actually interested in acquiring specific Japanese technologies appear to have been conceived almost as an afterthought. This lack of attention to practical considerations involved in the complex process of effectively transferring technology from one country to another would eventually lead to numerous difficulties when FS-X R&D actually got under way.

Equally revealing is the extraordinary deficiency of knowledge on the U.S. side regarding specific Japanese technology developments, particularly in military R&D, as well as the general lack of interest within the DoD as a whole, the military services, and even among U.S. defense contractors in finding out more. Conventional wisdom on the American side held that the Japanese had developed many interesting commercial technologies and manufacturing processes that might have military applications. U.S. officials, however, had little detailed knowledge about specific technologies that might be of interest and how precisely they could be applied to U.S. defense programs. With respect to military R&D, most American experts in government and industry believed Japan had little to offer the United States. When a DoD technical team visiting Japan in 1984 discovered that the Japanese were developing a radically new type of fire-control radar for a new fighter, the information apparently languished at the Pentagon until much later, when technology access became a hot political issue during the height of the FS-X controversy in Congress. When the FS-X controversy heated up, DoD officials latched onto the Japanese radar technology as something of potential value to the U.S. defense industry that the U.S. side could demand from Japan. Yet, very little was known about the Japanese technology, and little genuine interest to find out more existed on the American side.

The lack of detailed U.S. knowledge of Japanese developments in defense-related technology was hardly due solely to shortcomings on the American side. During the early 1980s and later during the initial phases of the FS-X program, the Japanese government and industry clearly resisted both sharing detailed technical information with the Pentagon and transferring dual-use commercial or military technology to the United States. A variety of domestic political and understandable commercial considerations primarily explain the Japanese reticence. However, there may have also been a conscious desire within the Japanese military R&D establishment and industry to shield some of their more interesting defense-related technology developments from the prying eyes of the Pentagon and American contractors.

By the mid-1980s, some American officials had become increasingly exasperated with what they perceived as persistent foot-dragging by the Japanese over the question of technology reciprocity. Years of difficult negotiations had been necessary merely to establish the general principle of U.S. access. Although a few relatively minor examples of the successful transfer of specific Japanese defense-related technologies to the United States took place during this period, Pentagon officials involved in the initiatives remained dissatisfied with both the Japanese level of cooperation and the continuing lack of interest among the U.S. services and American defense contractors. Ultimately, the FS-X program became a critical test case for the concept of technology reciprocity, as both supporters and opponents of the FS-X program increasingly used the issue of technology transfer to justify their positions.

This chapter reviews the successes and failures of the U.S. quest for technology reciprocity with Japan in the first half of the 1980s as background to the much higher-visibility debate over technology transfer in the late 1980s that ultimately transformed the fundamental emphasis of the FS-X program.

JAPAN'S DEFENSE BUILD-UP AND THE CONCEPT OF BURDEN-SHARING

The 1970s witnessed the beginnings of a fundamental shift in the global power relationship between the United States and Japan. Undisputed U.S. military and strategic predominance in the Pacific region began to erode as Japan emerged as a global eco-

conomic power of the first order. Through the late 1960s, the U.S.-Japan security relationship remained overwhelmingly one-sided, with U.S. forces carrying the primary burden for regional security and the defense of Japan. Over the next decade, however, a variety of factors raised doubts about the long-term U.S. military commitment to Japan and other regional allies. These doubts emerged with the declaration of the Nixon Doctrine in 1969 calling for greater participation of allies in regional defense, the U.S. defeat and final withdrawal from Vietnam in 1975, the pursuit of détente with China over Taiwanese objections, the widespread discussion of U.S. troop withdrawal from South Korea during the Carter administration, and declining U.S. defense expenditures. At the same time, a dramatic buildup of Soviet military forces in the Far East during the second half of the 1970s heightened concerns among U.S. and Japanese officials about a growing regional threat. Japanese political leaders and public opinion slowly came to recognize the need for the Japanese Self-Defense Forces (SDF) to play a larger role in the defense of Japan (Olsen, 1985; Vogel, 1989).

U.S. defense officials and Congress responded to these trends with calls for greater defense "burden-sharing" and reciprocity with allies. In the case of Japan, the United States began pressing for higher defense spending, the acquisition of larger numbers of more capable weapon systems, formal acceptance of additional mission responsibilities, and closer coordination of SDF planning, mission roles, and training with U.S. forces. In October 1976, the Takeo Miki government adopted the new National Defense Program Outline or *Taiko*,¹ which, while capping the overall size of the Japanese military forces, promoted greater domestic consensus on defense and heralded a new Japanese commitment to quantitative and qualitative improvement of the SDF weapon system inventories (Levin, 1988, pp. 8-12). Throughout the 1970s, Japanese defense expenditures increased in real terms by nearly 8 percent per year. Japan authorized a defense modernization and buildup program that included procuring some of the most capable and expensive weapon systems in the world, including the McDonnell-Douglas F-15A/B Eagle air superiority fighter, the Bell AH-1S attack helicopter, and numerous other advanced types of military aircraft, armored vehicles, fighting ships, and tactical missiles. In

¹*Boei keikaku no taiko* in Japanese.

1978, U.S. and Japanese negotiators completed the *Guidelines for Japan-U.S. Defense Cooperation*, a detailed agreement for promoting greater joint defense planning and training for combat operations, intelligence, and logistics.²

However, the U.S. concept of greater burden-sharing did not focus exclusively on promoting operational coordination and higher allied defense budgets. By the late 1970s, DoD officials increasingly stressed the potential benefits of the cooperative development of military technologies and weapon systems. During the Carter administration, rationalization, standardization, and interoperability (RSI)³ became a favorite term in the halls of the Pentagon. The concept envisioned a more rational and economical utilization of the R&D and procurement budgets of the United States and its allies by dividing pooled development and production tasks, sharing technologies, and jointly procuring the same weapon systems or subsystems. RSI was also expected to reduce logistical and operational incompatibilities among allies by fielding identical or similar weapon systems.⁴

Most of the discussion of RSI in the 1970s concentrated on greater equipment procurement collaboration with NATO European allies, in part because these allies collectively spent considerable money on military R&D—often duplicating U.S. efforts—and possessed a large and capable defense industrial base.⁵ Leading NATO allies, such as the United Kingdom, Germany, France,⁶ and Italy, fielded numerous advanced and highly sophisticated weapon systems designed and developed entirely—and often jointly—in Europe (Lorell, 1980). While Japan indigenously developed many of its own land and naval systems, it mainly license-produced ver-

²The guidelines have been published in Japan Defense Agency (1990), pp. 295–299.

³That is, rationalization of R&D expenditures and resources and standardization and interoperability of equipment.

⁴The RSI literature from the 1970s is vast. Two examples are Tucker (1978) and Defense Science Board (1978).

⁵U.S. defense planning throughout most of the Cold War also overwhelmingly stressed the European theater of operations. The United States has promoted collaborative weapon procurement in NATO since the earliest days of the Alliance. See Vandevanter (1964).

⁶France withdrew from the combined NATO military structure in the early 1960s. However, the French armed forces have trained and planned to operate in a coordinated fashion with NATO forces since the late 1970s.

sions of U.S.-designed and -developed weapons for its major front-line aerospace systems, particularly those that were most technologically sophisticated and expensive to develop, such as fighters and other combat aircraft, helicopters, and tactical missiles.

The emerging interest in collaborating with Japan focused on the potential value for U.S. defense purposes of acquiring advanced technologies developed by Japanese industry for commercial applications, particularly in the areas of electronics and materials.⁷ By the late 1970s, defense planners increasingly stressed the importance of emerging "critical technologies" for the developing future "smart" and "brilliant" munitions and weapon systems necessary to maintain the technological edge of the American military. At the same time, concerns were mounting that the U.S. position of global leadership in defense-critical high technologies was eroding. In 1979, DoD implemented the recommendations of an earlier Defense Science Board (DSB) Task Force study for establishing a "Military Critical Technologies List" to help track and promote key new technologies.⁸ The list of 15 critical technologies heavily emphasized electronics, including such areas as microwave component technology. Not surprisingly, Japan's emergence as a major world player in high technology, particularly in microelectronics, attracted increasing attention and interest. Carter administration officials came to view access to Japanese state-of-the-art technologies as an important new means of developing more defense reciprocity, thus advancing the goal of greater burden-sharing while bolstering the U.S. defense technology base (Hills, 1983, pp. 205-223).

Separating security issues from trade and economic issues was a cardinal rule of Carter and Reagan administration DoD officials. Yet, clearly, an important factor stimulating greater DoD interest in defense technology reciprocity with Japan was growing trade friction and the resulting political pressure from Congress for remedial action. Since the 1950s, defense technology had flowed overwhelmingly in one direction—from the United States to Japan through military licensed-production programs. This asymmetry

⁷One of the best overviews of this issue is Rubinstein (1986). Another version of this paper was published as Rubinstein (1987).

⁸The DSB is an advisory body to the Under Secretary of Defense for Research and Engineering (later the Under Secretary of Defense for Acquisition) consisting of prominent representatives of defense industries.

caused little concern while U.S. technological and economic pre-eminence remained unquestioned. Indeed, as late as 1975, the United States enjoyed a visible trade surplus with Japan of close to \$0.5 billion. Five years later, however, this surplus had become a U.S. trade deficit with Japan of over \$10 billion. U.S. high-technology electronics manufacturers feared dramatic losses of global market share to the Japanese. Allegations of Japanese dumping and structural barriers to imports proliferated. Trade friction with Japan became a major issue in the 1980 presidential election campaign.⁹ The decline of U.S. "smokestack" industries, consumer electronics, and other sectors, as well as the growing trade deficit with Japan, led to congressional complaints that Japan was getting a "free ride" on defense while battering U.S. industry with unfair trade practices (Drifte, 1989, p. 93). In this atmosphere, the one-way flow of sophisticated defense technologies to Japan in military-licensed production programs became increasingly unacceptable to Congress.

Thus, by the late 1970s, Pentagon officials responsible for equipment acquisition and military R&D began pursuing greater reciprocity with Japan in two distinct but closely related areas: (1) collaborative weapon system development, primarily as a means of sharing the burden of R&D costs and attaining equipment interoperability, and (2) special access to Japanese technologies for application to U.S. defense equipment programs, as a means of balancing the historical one-way flow of U.S. defense technology to Japan and of taking advantage of emerging Japanese technological capabilities, particularly in electronics and materials.

DEVELOPING A LEGAL FRAMEWORK FOR ACCESS TO JAPANESE DEFENSE TECHNOLOGY

Early U.S. Initiatives

William Perry, the Under Secretary of Defense for Research and Engineering, was one of the most vocal advocates of increased U.S. procurement collaboration with NATO and other key U.S. al-

⁹On U.S.-Japan trade friction, see Hills (1983), pp. 209-212, and Olsen (1985), pp. 60-61.

lies in the late 1970s.¹⁰ Midway through the Carter administration, Perry began pressing the Japanese on the need for greater defense technology reciprocity. One of the earliest efforts to actually gain access to specific Japanese technology for U.S. defense purposes was initiated through the U.S. military mission in Tokyo. In 1978, U.S. embassy officials argued for inclusion of Japanese firms in the proposed DoD program to develop very-high-speed integrated circuits (VHSIC) for military applications. The rationale was to acquire information on lithography and dry-etch technology, and equipment development, from a cooperative Japanese research program for developing very-large integrated circuits sponsored by the Ministry of International Trade and Industry (MITI). Although U.S. government officials rejected this suggestion because of concerns over the possible transfer of sensitive VHSIC technologies to Japan, increased efforts continued on other fronts (Hills, 1983, pp. 212-214).

By 1979, DoD and Japanese Defense Agency (JDA) officials had inaugurated direct discussions and planning about greater coordination of military R&D and procurement. These discussions finally bore fruit in September 1980 when a working-level body explicitly intended to facilitate greater R&D and procurement cooperation, the Systems and Technology Forum (S&TF), was established. The S&TF provided a formal channel for direct discussions between the primary offices in both countries responsible for military R&D: the DoD Office of the Under Secretary of Defense for Research and Engineering (OUSDRE) and the JDA Equipment Bureau. Unfortunately, the Japanese government almost immediately nullified the potential usefulness of the S&TF for gaining access to Japanese technology by ruling that long-standing Japanese policy prohibitions against the export of military equipment would apply equally to the export of military technologies to the United States (Rubinstein, 1986, p. 50; JDA, 1990, pp. 182-183, 301).

¹⁰Perry also strongly promoted the "family of weapons" concept whereby the United States and its allies would separately develop different but complementary weapons, and then each reciprocally purchase the resulting weapons.

New Initiatives from the Reagan Administration

President Reagan entered office in January 1981 determined to strengthen America's armed forces and strategic alliances against a growing Soviet threat. One of the first priorities of his new Secretary of Defense, Caspar Weinberger, was to fortify the U.S.-Japan security relationship by convincing the Japanese to accept greater regional defense responsibilities to help bolster the U.S. position against the Soviets in northeast Asia. In May, Prime Minister Zenko Suzuki met with President Reagan and agreed to expand SDF missions and roles, including an apparent acceptance of primary SDF responsibility for defending strategic sea lanes out to a distance of 1,000 n mi from Japan (see Olsen, 1985, pp. 94-97).

At the same time, DoD launched a major new offensive to overcome Japanese resistance to greater defense technology reciprocity as part of a broader effort to increase equipment procurement collaboration with allies (Tow, 1983). In part, this was also a response to growing pressure from Congress over continuing trade friction with Japan. For example, in March 1981, Representative Sam Gibbons, Chairman of the House Subcommittee on Trade, formally asked the General Accounting Office (GAO) to undertake a comprehensive study of the 1978 DoD decision to permit Japan to license-produce the McDonnell-Douglas F-15 fighter. Like many representatives, Gibbons was becoming increasingly concerned about the long-term consequences for U.S. industrial competitiveness of the transfer of advanced aerospace technology to Japan through military licensed-production programs. He was particularly interested in knowing what the United States received in return from Japan for the F-15 technical data packages.¹¹

The process began in earnest for the Reagan administration in June 1981, when Secretary Weinberger and other DoD officials met with Moura Joji, JDA Director-General, urging him to consider new approaches to increasing military R&D cooperation and defense technology reciprocity. Allegedly, Weinberger also threat-

¹¹See GAO (1982). Part of this concern arose from the persistent pressure applied by the Japanese government on U.S. officials to release additional F-15 technology that had originally been denied at the beginning of the licensed-production program. Many observers had been particularly upset by William Perry's decision in 1980 to release F-15 composite materials technology to Japanese industry, a move strongly opposed by the U.S. Air Force. Interview with a former DSAA official, January 15, 1993.

ened to reconsider the long-standing policy of permitting Japanese licensed production of U.S. weapon systems if the Japanese were not forthcoming (Drifte, 1986, p. 80). Senior DoD and JDA officials met at least two more times in September for further discussions. Richard Delauer, the new Under Secretary of Defense for Research and Engineering, pushed for obtaining a formal agreement by the end of the year from the Japanese that in principle would permit the transfer of defense-related technology to the United States.

U.S. officials focused on reversing the Japanese government decision in 1980 to include military technology transfer to the United States under its ban on arms exports, which had undermined the potential usefulness of the newly created S&TF. Japanese prohibitions were based on the "Three Principles on Arms Exports" announced in 1967 by the Sato cabinet. The Three Principles banned all military equipment exports to Communist countries, to countries embargoed by UN resolutions, and to countries engaged or likely to be engaged in conflict. In 1976, the Miki cabinet had extended restrictions to include virtually all military exports to all nations (JDA, 1990, p. 183).

U.S. officials used a number of approaches with the Japanese to try to get around these restrictions. They argued that the security treaty between the United States and Japan, and the critical role the United States played in Japan's defense, allowed it to be specially exempted from the prohibitions on exporting defense technology. More specifically, DoD insisted that the U.S.-Japan Mutual Defense Assistance Agreement (MDAA) signed in 1954 specifically authorized the sharing of defense technologies.¹² U.S. officials also noted that Japanese prohibitions were based primarily on earlier cabinet policy directives, not legislation or constitutional law (see Drifte, 1986, pp. 73ff). Further, the Miki cabinet restrictions called only for "restraint" rather than an outright prohibition on arms exports to countries other than those included in the Three Principles.

¹²U.S. officials particularly emphasized Article IV (as quoted in Rubinstein, 1986, Appendix A):

The two Governments, upon the request of either of them, make appropriate arrangements providing for the methods and terms of the exchange of industrial property rights and technical information for defense

There was also some initial hope at the Pentagon that distinguishing between "dual-use" and "military" technology might facilitate U.S. access. Dual-use technologies are those that have both commercial and defense applications, whereas military technologies are seen as unique to weapon systems or munitions. Unfortunately, this distinction is rather artificial and often difficult to apply in practice. Nonetheless, the Japanese technologies of prime interest to the Pentagon, such as microelectronic devices, laser optics, advanced ceramics, and composites (Olsen, 1985, p. 68; Hills, 1983, p. 218), were often developed initially for civilian purposes by commercial contractors without JDA involvement. Thus, Pentagon officials hoped that transfer of such technologies for U.S. defense purposes might be accomplished on an industry-to-industry basis and would not be subject to Japanese restrictions on arms exports.

Japanese Resistance—And Eventual Compromise

However, it rapidly became clear that active Japanese government intervention would be required to facilitate significant defense-related transfers of dual-use technology, even if it was commercially developed and privately owned. Although Japanese government prohibitions on the export of defense technology did not technically apply to dual-use technology, a variety of circumstances inhibited industry-to-industry collaboration on U.S. defense projects. Some Japanese defense-oriented companies or divisions of larger companies expressed interest in greater collaboration with U.S. firms as a means of acquiring U.S. defense technologies and enlarging their potential market (for example, see Tabata, 1983, p. 119). But the majority of Japanese commercial firms had little incentive to negotiate the transfer of commercially developed dual-use technologies to U.S. defense firms, particularly given the widespread antimilitary sentiment of the Japanese public. Some firms feared that commercial technology transferred to U.S. defense programs would become classified and would be made unavailable for future commercial purposes. Few Japanese companies wished to become entangled in DoD's complicated procurement regulations and requirements. In addition, U.S. companies had a limited presence in Japan and had little knowledge of Japanese technology developments (Office of Technology Assessment, May 1990, p. 69; Neff, 1983).

The Japanese government did not respond enthusiastically to any of DoD's arguments for eliminating prohibitions on defense technology exports to the United States or encouraging the transfer of dual-use technologies for U.S. defense purposes. While the ruling Liberal Democratic Party (LDP) recognized the need for greater reciprocity to bolster the U.S.-Japan Mutual Security Treaty, widespread concern persisted over the domestic political consequences of relaxing the policy on military exports, even to the United States. Perhaps more important, MITI, the Ministry of Finance (MOF), and some industry interests strongly opposed the DoD initiatives out of suspicion that the U.S. government was simply seeking valuable Japanese commercial technologies to improve general U.S. industrial competitiveness.¹³

MITI's opposition represented a major stumbling block, because this ministry had to review all commercial technology transfers to the United States. One of MITI's major concerns remained that U.S. firms might use dual-use technologies transferred for military applications for commercial purposes (Drifte, 1989, p. 95). Ironically, this concern was a mirror image of the accusations commonly made by U.S. critics about Japanese commercialization of U.S. defense technologies acquired in licensed-production programs. MITI was also concerned about domestic sensitivities to applying commercial technologies to U.S. defense programs.

Thus, DoD's hope of acquiring dual-use defense-related technology through greater industry-to-industry cooperation outside of formal government channels met with as much or more resistance as the attempt to gain direct government access to Japanese military technology. The net result was that the Japanese government did little to accommodate the initial Weinberger requests.

In March 1982, GAO issued the results of its study requested by Congress on the F-15 licensed-production program with Japan (GAO, 1982). This report contributed to the growing public linkage in the United States between trade and industrial competitiveness issues and foreign military licensed-production programs, raising the political pressure on both the DoD and the Japanese to formulate a compromise solution. This widely read and influential report concluded that key Japanese objectives for entering into military

¹³"The Electronics Revolution and the Ban on Export of War Materials" (1982), p. 12; Neff (1981), p. 66. Also see Tow (1983), p. 12; Drifte (1989), p. 95.

licensed-production programs were "obtaining advanced technology, enhancing their high-technology employment base," and "developing future export industries." (GAO, 1982, pp ii and 4.)¹⁴ The GAO study emphasized that the U.S.-Japan defense technology relationship lacked reciprocity (GAO, 1982, p ii):

In recent years . . . Japan has progressed in some areas, such as electronics and laser technology, to the point that some officials believe the United States can benefit from Japan's achievements. To date, however, military technology transfer continues to be a "one-way street" with technology flowing from the United States to Japan.

Despite such pressure, the Suzuki government continued to resist U.S. initiatives. It took a change in government in Japan to bring about greater flexibility. Top-level Japanese policy finally reversed with the departure of the Suzuki administration and the advent of Yasuhiro Nakasone as Prime Minister in October 1982. Nakasone favored greater Japanese defense efforts and a closer security relationship with the United States. He believed that acceding to U.S. demands on the transfer of military-related technology would alleviate U.S. pressure for greater burden-sharing and help reduce trade friction.

In January 1983, the Nakasone cabinet issued a statement exempting the United States in principle from export prohibitions on Japanese military technology.¹⁵ The basis for this exemption was the clear recognition of the need for greater reciprocity in the U.S.-Japan security relationship:

In improving its defense capacities, Japan has been benefiting from various kinds of cooperation extended by the United States, including transfer of U.S. technologies to Japan. In view of the recent advance of technology in Japan, it has become extremely important for Japan to reciprocate in the exchange of defense-

¹⁴For a typical press account, see "GAO Report Says Coproduction Pacts Aid Japan Industry" (1982).

¹⁵It is important to note that this exemption applied only to technology, not to defense equipment.

related technologies in order to ensure the effective operations of the Japan-U.S. Security Treaty¹⁶

Both sides recognized the need to negotiate a government-to-government agreement to provide a formal structure to facilitate the implementation of the new Nakasone cabinet policy. Negotiations, however, soon deadlocked over a variety of definitional and procedural issues. The Pentagon sought to finalize a clear implementation framework that would facilitate the routine transfer of both dual-use and military defense-related technologies to the United States. To this end, U.S. negotiators argued for a single broad implementation agreement, while the Japanese held out for a policy of reviewing each U.S. technology transfer request on a case-by-case basis.¹⁷ Pentagon negotiators pressed for a broad definition of military technology so that dual-use technologies could be included in the overall framework (Tow, 1988). The Japanese insisted that the specific implementation framework should apply only to very narrowly defined military technologies. Officials also began discussing specific candidate weapon development programs for collaboration and continued the effort to identify specific Japanese technologies of interest to DoD. However, domestic political pressures led Nakasone cabinet officials to retreat almost immediately from the spirit of the January agreement by implying that collaborative weapon development was unlikely to take place in the foreseeable future (Tow, 1983, pp. 13-14).

With the negotiations stalled, Richard DeLauer, the Under Secretary of Defense for Research and Engineering, directed the DSB Task Force to assess independently the problem of acquiring Japanese defense-related technologies to assist in rapidly implementing the new Japanese policy. The DSB Task Force was chaired by Malcolm Currie, former Under Secretary of Defense for Research and Engineering, and included Gerald Sullivan, Deputy Under Secretary for International Programs, and senior representatives from leading U.S. defense contractors. The task force was

¹⁶From "Statement of the Chief Cabinet Secretary on Transfer of Military Technologies to the United States," January 14, 1983, reproduced in JDA (1990), p. 301.

¹⁷"Japan to Transfer Military Technology to the U.S." (1983); Rubinstein (1987), p. 46.

just completing a major study on industry-to-industry defense collaboration with NATO European allies. The NATO study envisioned greater weapon procurement collaboration with European allies, but did not see major potential for flowback of new technologies to the United States (OUSDRE, 1983). The central objective of the Phase II Japan study, however, was clearly to help establish "a two-way flow of defense-related technology, so that the United States may benefit from Japan's R&D." (OUSDRE, 1984, pp. 4-5 and Appendix A.) A fundamental assumption of the study approach was that "the long era of unilateral technology transfer from the United States is ending," and that the "prerequisite for continued transfer of U.S. advanced defense technologies will generally be reciprocal transfer of Japan's dual-use and military technologies." (OUSDRE, 1984, pp. 4-5 and Appendix A.) However, the DSB Task Force immediately encountered delays and problems in trying to arrange an information-gathering trip to Japan.

With the negotiations at a standstill, Defense Agency Director-General Kazuo Tanikawa met in Washington with Secretary Weinberger for direct high-level consultations. With an official state visit to Tokyo planned by President Reagan for November, pressure was mounting on the Japanese to break the deadlock and sign some kind of agreement prior to the president's trip. At the same time, general trade friction with Japan continued to mount throughout 1983, as a special White House committee led by Clyde Prestowitz received wide publicity for its findings that unfair and illegal Japanese trade practices were undermining the U.S. machine-tool industry (see Alexander, 1983).

Eventually, the Japanese relented and granted the DSB Task Force approval for a fact-finding trip to Tokyo in late October for a week of meetings with government and industry officials. More importantly, a few days after the departure of the DSB Task Force from Tokyo and a day prior to the arrival of President Reagan in Japan, the Nakasone cabinet approved the "Exchange of Notes on the Transfer of Japanese Military Technology," establishing a more formal structure for defense technology transfer (see OUSDRE, 1986b, Tab B).

The Exchange of Notes and the Establishment of the Joint Military Technology Commission

The Exchange of Notes contained four essential elements. First, it confirmed the January Nakasone cabinet directive exempting the United States from the prohibitions on the export of military technology. Second, it created the Joint Military Technology Commission (JMTC), a permanent interdepartmental committee intended to facilitate transfer of defense-related technology to the United States. Third, it called for the negotiation of detailed arrangements for the transfer of military technologies. Finally, it formally noted that the Japanese government placed no special restrictions on transferring dual-use technologies to the United States for military applications and, indeed, actually welcomed such transfers.

Although some observers portrayed the Exchange of Notes as a landmark agreement, in reality it resolved very few of the substantive problems troubling U.S. officials in their year of negotiations following the original Nakasone cabinet policy change favoring defense technology exports. The agreement contained no detailed framework for actually transferring military technology, as originally hoped by U.S. negotiators. Most fundamental implementation issues remained unresolved. Instead, the Exchange of Notes merely called for the elaboration of detailed arrangements in future negotiations (OUSDRE, 1986b, pp. 2 and 3).

The establishment of the JMTC, however, was a significant accomplishment. One major shortcoming with the S&TF established in 1980 was that it included only DoD and JDA representatives. The JMTC expanded membership considerably beyond the S&TF to encompass other Japanese government agencies whose cooperation was proving to be crucial to successfully transferring defense-related technology to the United States. Thus, representatives from both MITI and the Ministry of Foreign Affairs (MOFA) would join their colleagues from the JDA as permanent members on the new commission. The U.S. members of the JMTC represented the U.S. Embassy and the Mutual Defense Assistance Office (MDAO) in Tokyo. The Exchange of Notes sanctioned the JMTC as the primary working-level body for consulting on and reviewing all U.S. requests for Japanese military technology. A critical task assigned

to the JMTC was identifying candidate technologies for transfer to the United States.

At the time of the agreement, many U.S. officials believed a major shortcoming was that the agreement explicitly excluded dual-use technology and enshrined the Japanese government's extremely narrow definitions of defense technology. For the purpose of the agreement, the United States accepted the Japanese definition of military technologies as those "exclusively concerned with the design, production and use of 'arms' as defined in the Policy Guideline of the Government of Japan on Arms Export of February 27, 1976" (OUSDRE, 1986b, p. 5). This limited definition basically included only firearms, ammunition, and explosives and military vehicles, vessels, aircraft, and their parts and seemed clearly to exclude commercially developed dual-use technology.

While the Japanese assured the United States that no special government restrictions would be placed on the export of dual-use technologies for U.S. defense purposes, the exclusion of such technologies from the formal government-to-government framework was nonetheless a setback from the perspective of the U.S. negotiators. The JMTC had been designated as the primary forum for consultations with the Japanese government on candidate technologies, yet its authority did not cover those dual-use technologies of primary interest to the Pentagon at the time.¹⁸ In his cover letter to the Exchange of Notes, Shintaro Abe, the Japanese foreign minister, justified the exclusion of dual-use technologies from the agreement by arguing that no special government intervention was necessary (OUSDRE, 1986b, p. 1):

[T]he transfer of any defense-related technologies other than military technologies from Japan to the United States of America has been and is in principle free from restrictions.

Furthermore, Abe noted that Japan "welcomes the transfer to the United States of America of defense-related technologies." In reality, of course, Japanese commercial contractors were extremely wary of transferring dual-use technologies to U.S. defense firms

¹⁸As a minor concession to U.S. concerns, the agreement authorized the JMTC to "discuss, where appropriate, matters concerning defense-related (dual-use) technologies." (OUSDRE, 1986b, p. 2.)

outside a formal government structure, and MITI could hardly be accused of encouraging such transfers in the past.¹⁹

After returning to the United States from its fact-finding trip to Japan, the DSB Task Force pinpointed this problem with the new agreement in its report to the DoD:

[T]he technologies eligible for transfer are defined quite narrowly, and are of much less interest to the United States than the defense-related dual-use technology. (OUSDRE, 1984, p. 30.)

According to the task force, the most interesting of these technologies were developed privately by commercial firms, with guidance and support from MITI or the Science and Technology Agency, not the Defense Agency. Thus, cooperation from these offices was critical.

The task force concluded that the formal Japanese government statement in the Exchange of Notes supporting the transfer of dual-use technologies to the United States removed a significant political and psychological barrier inhibiting Japanese firms from cooperating on an industry-to-industry basis on U.S. defense projects. Nonetheless, it recognized that serious problems remained. In the view of the task force members, Japanese firms still had many concerns, including doubts about receiving adequate compensation for their R&D investment and preventing the application of transferred technologies for U.S. commercial purposes (OUSDRE, 1984, p. 40).

The consequences of the failure to resolve these issues quickly became evident as new negotiations for the detailed implementation arrangements called for in the Exchange of Notes failed to make rapid progress. This is not surprising, since the original agreement was meeting with strong criticism and resistance in various government and industry circles in Japan. For their part, Japanese companies were still no more inclined to transfer dual-use technologies without an explicit government-to-government arrangement.

¹⁹See, for example, "The U.S. is Asking MITI to Promote the Transfer of Japanese Technology" (1983), p. 4, and "Between Japan and the U.S." (1983), p. 11.

The U.S. Demands for “Free and Automatic Flowback” of Derived Technology

While the negotiations over an implementation arrangement continued to make little progress, other DoD officials launched a separate and unrelated initiative in the summer of 1984 aimed at increasing technology reciprocity on licensed-production programs with Japan. This approach focused on stronger enforcement of existing provisions in licensed-production agreements with Japan for U.S. access to Japanese improvements to U.S. technology. This approach had the added benefit of providing a direct response to growing congressional concern over the long-term economic effects of licensed-production programs with Japan.

The 1982 GAO report on F-15 licensed production in Japan had harshly criticized the Pentagon for paying insufficient attention to the industrial and commercial implications of the one-way flow of advanced technology to Japan in military licensed-production programs. Licensed-production agreements routinely contained pro forma statements in “side letters” that called for the free flowback to the United States of any foreign changes or improvements in American technology. Historically, neither the United States nor its foreign partners paid much attention to these provisions. However, in 1984, the Japanese government needed to negotiate a revision of the original Memorandum of Understanding (MoU) signed in 1978 for the licensed production of the F-15 to fund an additional production batch of the aircraft. DoD officials entered the negotiations determined to strengthen the provisions on technology flowback and to make clear to the Japanese that the U.S. government now took these provisions seriously.²⁰

The Pentagon’s Defense Security Assistance Agency (DSAA) has the responsibility for negotiating MoUs for the licensed production of major U.S. weapon systems by Japan and other foreign countries.²¹ In 1982 and 1983, officials at DSAA and the U.S.

²⁰The following account is based largely on interviews with a former DSAA official and other government officials, August 7, 1992. Also see Chinworth (1992), pp. 109–110.

²¹DSAA can delegate the authority to negotiate MoUs for licensed-production programs to the appropriate U.S. military service. However, DSAA nearly always retains negotiating authority on politically important or sensitive programs. As a result, DSAA directly negotiates virtually all licensed-production agreements with

MDAO in Tokyo became convinced that, to emphasize the greater importance now placed on technology reciprocity, these provisions had to be removed from side letters and placed in the main body of the MoU. U.S. officials believed side letters to agreements were perceived as less binding than the MoUs. In the case of Japan, the more politically powerful MOFA signed the MoU, while side letters were signed by the JDA Equipment Bureau. U.S. officials wanted the MOFA to agree officially to the flowback provisions.

Perhaps more important, the Pentagon sought to strengthen the wording of the flowback provisions substantially. Existing MoUs in effect called on foreign licensees to make an honest effort to return improved technology of American origin to the United States. Now DSAA officials wanted to make technology flowback a mandatory and legally binding obligation. The JDA Equipment Bureau agreed to place these issues on the table for the upcoming renegotiation of the F-15 MoU. In August 1984, U.S. officials presented the Japanese with a draft MoU for the F-15 containing the mandatory flowback provisions. The wording required the Japanese to return all improvements to U.S. technology automatically, without cost, and without the need for a specific U.S. request. The American side was determined to walk away from the negotiations unless the Japanese accepted the new wording and format. Yet, during the initial discussions, the Japanese rejected the new provisions out of hand. The meetings adjourned without an agreement when Pentagon negotiators refused to soften the U.S. position.

Over the next several months, the U.S. side held firm on its position. Without an MoU, JDA could not move ahead with its new production batch of F-15s. Eventually, the Japanese began to waver. In December 1984, the Japanese gave in to American demands for mandatory flowback provisions within the MoU and signed the new F-15 agreement in the format desired by the Americans. DSAA believed it had won a major concession from the Japanese that would establish a significant new precedent for access to Japanese technology applied to military programs and that would reduce congressional criticism of the one-way flow of defense technology to Japan on licensed-production programs.

Japan. However, DSAA never manages actual programs. This task is usually undertaken by the appropriate armed service.

The 1984 F-15 MoU became a benchmark agreement for all other collaborative procurement programs with Japan. DSAA negotiated four additional major licensed-production agreements with Japan in 1985, and all of them used the F-15 MoU as the baseline.²² At a time when negotiations over an implementation arrangement for the Exchange of Notes were still completely stalled, DSAA's unbending position and ultimate triumph on the F-15 MoU served notice to the Japanese government that DoD was now absolutely committed to the principle of greater defense technology reciprocity.

Another major initiative launched about this same time on the highest political levels also reflected the fundamental change in attitude that had taken place in the U.S. government about defense technology reciprocity with Japan. In January 1985, President Reagan directly asked Prime Minister Nakasone to consider Japanese participation in the U.S. Strategic Defense Initiative (SDI) along with other American allies. This request, however, met with the same hesitation, resistance, and delays from the Japanese that U.S. officials encountered negotiating the implementation for the transfer of Japanese military technology. U.S. and Japanese government and industry representatives opened discussions on possible technical areas for collaboration on SDI. Yet Japanese concern over domestic sensitivities and other issues delayed an official response.²³

Negotiating the Implementation Arrangements

Meanwhile, the negotiations for implementation arrangements called for in the Exchange of Notes dragged on inconclusively throughout 1985. During this time, domestic political pressure on the Reagan administration to gain trade and technology concessions from Japan continued to mount. Several rounds of general

²²These agreements were for the licensed production of the Lockheed P-3C Orion antisubmarine warfare aircraft, the Sikorsky XSH-60 Seahawk helicopter, the Raytheon MIM-104 Patriot air defense missile, and the Raytheon AIM-7F Sparrow air-to-air missile.

²³Nearly two years later, the Japanese government finally gave an affirmative reply. However, in a manner similar to the aftermath of the 1983 Exchange of Notes, negotiators soon became entangled in drawn-out and complicated negotiations for an implementation agreement. See Rubinstein (1987), p. 47.

trade negotiations with Japan achieved few results. With the trade deficit with Japan approaching \$50 billion, the White House felt compelled to appoint a special interagency task force headed by the vice president to negotiate for greater access to the Japanese market and to prevent impending Japanese legislation that might permit unrestricted duplication of U.S. computer software (Prestowitz, 1992).

Against this backdrop of mounting trade pressures, U.S. and Japanese negotiators finally agreed in late December 1985 on a formal framework for implementing the Exchange of Notes. This agreement, "Detailed Arrangements for the Transfer of Military Technologies,"²⁴ included key provisions pushed by the Japanese government that, in the view of some American officials, severely undermined its potential effectiveness. The agreement essentially incorporated the Japanese position for a case-by-case consideration of each U.S. request for a specific technology. The Japanese members of the JMTC (JDA, MITI, and the MOFA) were empowered to judge the appropriateness of each technology request for transfer to the United States. Further, each technology transfer required a separately negotiated Memorandum of Implementation. In response to MITI's concerns about the possible commercialization by U.S. firms of transferred military technology, the arrangements restricted use of the technology exclusively to military applications. The U.S. government agreed to pay an R&D recoupment fee to the Japanese government. Further, the arrangements obligated U.S. contractors to transfer any changes or improvements in the technology back to Japan.²⁵

The signing of the detailed arrangements concluded the five-year quest of the Reagan administration to establish a framework for defense R&D collaboration and the acquisition of Japanese military technologies. Japanese government and industry resistance had been encountered along every step of the way, but persistent U.S. pressure had slowly moved the Japanese government in the direction U.S. officials wanted. From the U.S. perspective, the final framework was flawed in many respects. But at least a formal

²⁴Found in OUSDRE (1986b), Tab C.

²⁵OUSDRE (1986b), pp. 4-8. It should be noted that these provisions mirrored similar clauses in agreements signed by Japan for the licensed production of U.S. weapon systems.

structure was now in place. In addition, the requirement for obligatory flowback of Japanese technology that had been written into the F-15 MoU had now been firmly established in four other major program MoUs. The Pentagon had built the structure and laid the legal framework for acquiring Japanese defense-related technology. Now greater attention could be focused on actually identifying and acquiring the technology.

The detailed arrangements had reconfirmed, however, the narrow Japanese definition of military technology, thus excluding commercial dual-use technologies from the whole military technology transfer framework. DoD officials had, of course, long believed that Japanese commercially developed dual-use technologies held the greatest potential for U.S. defense applications. Because of MITI resistance and the unwillingness of many Japanese companies to cooperate on U.S. defense programs, acquisition of those technologies through industry-to-industry contacts seemed increasingly unlikely. Yet, by the end of 1985, at least some Pentagon officials had come to suspect that the United States had grossly underestimated the breadth and depth of Japanese military R&D, particularly in defense electronics. But finding out exactly what was of interest to the United States in Japanese military and dual-use technology developments was proving to be a slow and difficult process. That process had begun in earnest only in 1984 as the negotiations over the detailed arrangements got under way.

IN SEARCH OF A TECHNOLOGY

Up to the signing of the Exchange of Notes at the end of 1983, the U.S.-Japanese negotiations had focused largely on broad principles governing technology reciprocity between the two countries. With the initiation of negotiations for an implementation arrangement, details about the actual technologies of interest became more important. This was particularly true as the problem of acquiring Japanese military versus dual-use technologies became increasingly prominent. Although most experts believed Japanese commercially developed dual-use technologies held the greatest potential for U.S. defense applications, few possessed detailed knowledge about ongoing Japanese technology developments, either in military or commercial areas.

Despite this remarkable lack of knowledge, most government and industry technical experts in the U.S. military R&D community continued to dismiss Japanese military R&D. Japanese officials tended to reinforce this skepticism, while also playing down the value of their commercial technologies for U.S. military use. Since the beginning of the DoD technology initiatives in 1981, many Japanese industry representatives had insisted they actually possessed little technology of interest for U.S. defense applications. Typical is the statement of a senior manager at Mitsubishi Electronics Corporation (MELCO), representing the largest defense electronics contractor in Japan, who claimed Japan did not have "as great technology for military purposes as the U.S. thinks."²⁶ Nonetheless, despite the general lack of information, many on the U.S. side remained convinced that Japanese commercial technologies could be useful. Nearly all agreed, however, that much more detailed data had to be acquired on both Japanese military and commercial dual-use R&D developments.

In its final report, published in June 1984, for example, the DSB Task Force emphasized Japanese commercially developed dual-use technology but decried the dearth of specific information on it. In a confirmation of the conventional wisdom, the report concluded that Japanese "military technologies appear of little interest to the United States," but "much of Japan's current dual-use technology, particularly in process and manufacturing, could contribute to U.S. defense programs." (OUSDRE, 1984, p. 60.) Yet the report admitted that the U.S. scientific and engineering communities were "not very knowledgeable about Japanese technology." (OUSDRE, 1984, p. 60.) Malcolm Currie noted that, during the task force study, "it became clear how relatively little we know of the Japanese scientific and technical work, in contrast to the extensive knowledge of the Japanese about our work." (OUSDRE, 1984, p. iv.)

To help rectify this problem, the U.S. government initiated negotiations in early 1983 for the right to send formal government teams of scientists and engineers to Japanese government and industry facilities to conduct more in-depth assessments of Japanese technologies. These teams, headed by DoD procurement and R&D

²⁶Takeshi Abe, general manager of the government requirements marketing division of MELCO, as quoted in Neff (1983), p. 70.

officials, were intended to help identify specific technologies relevant to U.S. defense purposes and assess means of transferring them. Although the Japanese government agreed in principle to these technology assessment teams (TATs), the actual arrangement of visits proved difficult and time consuming.

At the time of the DSB Task Force visit to Tokyo in November 1983, the Pentagon still had not received approval for a TAT visit to Japan. The DSB group, however, attempted to conduct its own general appraisal of key Japanese technologies. The task force ultimately identified 16 dual-use technologies of particular interest for U.S. military R&D, ten of which were in the field of electronics, three in materials, and the remaining three in propulsion and production. Gallium-arsenide (GaAs) semiconductor devices, especially for microwave and high-speed logic applications, and microwave integrated circuits topped the list. Materials identified included composites, ceramics, and high-temperature materials. Manufacturing technology was also identified (OUSDRE, 1984, p. 42).

The task force dismissed the importance of Japanese military technology, in part because of the small size of the official military R&D budget (only about \$370 million for fiscal year 1984), and because direct government military R&D was limited to a single R&D agency, the JDA's Technical Research and Development Institute (TRDI). Although the Task Force recognized that "a significant but indeterminate amount of military R&D is performed by industry with its own funds" and that Japan was "embarking on some very ambitious programs [for] next-generation fighter avionics" and other military systems and subsystems, little specific data was available to assess them (OUSDRE, 1984, pp. 33, 59, 141-142).

The task force study therefore emphasized the need for significantly more detailed information on actual military and commercial R&D developments and plans in Japan for the successful implementation of the Exchange of Notes. Consequently, throughout early 1984, DoD continued to press for Japanese permission for visits by U.S. TATs. Based on the task force technology priority recommendations and other information, DoD focused first on acquiring more information on Japanese millimeter/microwave and electro-optics technologies. OUSDRE gathered together a team of eleven senior scientists and engineers from government and industry experienced in military R&D in these areas. Team members

began meeting to develop objectives and priorities for a possible trip to Japan.

Of Gallium Arsenide, Integrated Circuits, and Military Radars

It came as no surprise that the DSB Task Force placed GaAs semiconductor devices and microwave integrated circuits at the top of its list of key Japanese technologies of interest or that DoD selected millimeter-wave and microwave technologies for evaluation by the first TAT. Microwave component technology had been selected as one of the 15 key technologies identified as early as 1979 on the first DoD Military Critical Technologies list. At about the same time, DoD had begun to take note of Japanese developments in GaAs devices under way in various programs sponsored by MITI (Witt, 1990). The U.S. military R&D community viewed these technologies as among the most critical for developing the next generation of highly advanced radars, communications, electronic-warfare jammers, and "brilliant" precision-guided munitions that were expected to provide enormous battlefield leverage for the high-technology military forces of the 1990s and beyond.

Microwave integrated circuits based on GaAs device technologies were of particular interest to DoD and the U.S. military services for the development of a radically new type of combat radar employing active phased array (APA) antennas. Conventional radars employ the familiar antenna dishes or arrays mounted on gimbals that mechanically scan the horizon and are powered by electric or hydraulic motors. These are the types of radars deployed on current U.S. combat fighter aircraft, such as the F-15 and F-16. APA radars replace the mechanically scanned antenna dish with a fixed array of hundreds of individual solid-state transmitting and receiving (T/R) modules that use electronic phase-shifting beam steering in place of mechanical scanning. APA radars provide numerous advantages over conventional radars, particularly for fighter aircraft, including lower radar cross-section (greater stealthiness), simultaneous multiple target engagement capabilities, extended target detection range, higher survivability, greater reliability, and reduced weight and size (Longuemare, 1990; General Research Corporation, 1990, pp. 2-1 to 2-6).

U.S. defense contractors and military research centers had been working on the development of phased array radar since at least 1964, when the U.S. Air Force commenced the Molecular Electronics for Radar Applications program.²⁷ Early efforts used existing silicon semiconductor technology for the microwave emitting modules. However, this technology did not permit adequate power output performance in the necessary frequency ranges. In the early 1970s, research demonstrated that a new semiconductor technology based on GaAs instead of silicon might provide the necessary power amplification in the required X-band microwave range. By 1978, the development of GaAs integrated circuits using field effect transistors (FETs), pioneered in the United States by Texas Instruments, RCA, and Raytheon, opened the possibility for making much simpler, higher-power T/R modules for insertion in active antenna arrays. The U.S. Naval Research Laboratory (NRL) began a program in 1980 to develop such modules for application in future tactical fighter aircraft radars. In 1983, the U.S. Air Force launched the Solid State Phased Array program to develop similar T/R modules and mount them into a demonstration antenna array.²⁸

Both the Navy and Air Force programs used "hybrid" integrated circuits in their T/R modules, made up of many individual GaAs FETs. However, by the early 1980s engineers focused increasingly on the problem of reducing the number of hybrid integrated circuits in each T/R module by developing highly sophisticated GaAs monolithic microwave integrated circuits (MMICs). In 1979, DoD's Defense Advanced Research Projects Agency launched a highly ambitious effort to develop a T/R module using a single GaAs MMIC chip. Westinghouse Advanced Technology Laboratories also began a major company-funded R&D effort to advance GaAs MMIC technology in 1983. Other U.S. defense electronics firms joined the competition.

²⁷This account is drawn from McQuiddy et al. (1991) and Rhea (1986).

²⁸DoD also supported the development of passive phased-array radars. These relied on a traveling-wave tube as a single source of power, which was then distributed to the individual "passive" emitter modules making up the antenna array. This technology, however, resulted in a substantial loss of power and relatively low scan rates. GaAs integrated circuit technology permitted the development of much more efficient "active" aperture arrays, in which each module in the antenna array generated its own microwave energy.

Engineers expected the push toward fewer, more capable GaAs MMICs for providing the microwave functions in T/R modules to dramatically simplify module manufacture and greatly reduce costs. GaAs MMICs would also allow much smaller T/R modules to be fabricated, thus permitting the insertion of large numbers of elements in antenna arrays small enough to fit in the nose of a fighter aircraft. It was widely recognized, however, that developing such technology, along with economical fabrication methods, would pose major technological challenges and require substantial R&D investment.

Therefore, it was no surprise that the first TAT included a few leading industry and government experts on radar and other defense applications of GaAs devices and MMICs. Prominent among them was the Head of the NRL's Microwave Technology Branch, which in 1980 had launched the most important government military program at the time for the development of GaAs T/R modules for tactical fighter fire-control radars. These experts were interested in seeing any advanced GaAs or silicon FET solid-state devices under development by the Japanese. These included millimeter-wave devices (30–300 GHz), useful for missile-seeker heads and other defense applications, and microwave devices (1–30 GHz), which are used in direct broadcast satellite systems, cellular phones, and local area networks (LANs). The X-band microwave range (8–12 GHz) has direct applications for APA fighter radars (see DoD, 1985, Appendix A).

However, the majority of the members of the TAT were laser and electro-optical experts, and this was really the primary emphasis of the group. The members included DoD and service technology specialists, as well as five senior engineers and scientists from the defense electronics industry.

The First TAT Visit to Japan

After considerable negotiation, the Japanese government finally granted permission for the first TAT to visit Japan in July 1984. During its 11-day trip, the team visited eight private corporate labs and two research centers operated by JDA's TRDI, as well as meeting with JDA Equipment Bureau and MITI officials. After years of DoD interest and prodding, this trip represented the first time senior U.S. government and industry military technical ex-

perts had the opportunity to examine ongoing developments in Japanese defense-related electronics technology officially.

Most TAT members believed that what they saw on the trip confirmed the conventional wisdom about Japanese military and commercial technologies. Several members felt that most of the military R&D programs for specific weapon systems they were actually permitted to see at the laboratories of the Defense Agency's TRDI were behind U.S. efforts. Japanese commercially developed technology, however, was seen as generally equaling, and sometimes surpassing, U.S. technology. Team members agreed that Japan's greatest strength was in commercially applying the technologies and developing superior manufacturing methods. Thus, in the official trip report published by the Pentagon in May 1985, the TAT concluded that "while Japan lags in defense system development," its millimeter-wave and electro-optical technologies compared favorably with those in the United States and benefited from impressive production engineering that resulted in low-cost, high-quality manufacturing capabilities for materials, components, and complete systems (DoD, 1985, pp. ii, 3-6).

The U.S. experts identified 36 specific technologies of interest to the United States for defense applications, separating them into three general categories:

- Design and test data for
 - T/R modules
 - LANs
 - Optical data storage
 - DFB lasers at 1.3 μm
 - Fiber-optic gyros
 - Active aperture systems
 - High-electron-mobility transistors
 - Mercury-cadmium-telluride
 - Schottky barrier IR devices
 - Voice recognition and synthesis
 - Lithium batteries
 - Laser diodes
 - LAN components
- Production methods and know-how for
 - Broadband phased arrays

- Seekers
- Fiber-optic LANs
- FETs
- GaAs wafers
- IR fiber-optic waveguides
- Liquid crystal displays
- Electric luminescent displays
- Low-cost gyros
- III-V materials
- Barium-zinc-tantalum compound materials
- Automated manufacture of electro-optical materials and devices
- Erasable optical data storage
- Materials for carbon dioxide lasers
- Potential supply source for
 - Solid-state imager chips
 - Positive-intrinsic-negative FETs
 - Laser diodes
 - Avalanche photodetectors
 - Electro-optical materials
 - High-density memories
 - Microwave and millimeter-wave components
 - GaAs wafers.

Most of the items in the three categories were actually subsystems, parts, or components. One category designated items the United States might consider buying directly from Japan, including microwave and millimeter-wave components and GaAs wafers. More interesting from the perspective of acquiring Japanese technology were the other two categories. These identified items of interest because of their design and engineering or because of the methods and know-how used in their production. T/R modules topped the list of interesting designs. This list also included active aperture systems. Broadband phased arrays headed the list of interesting production technologies, followed by (missile target) seekers. Also on this list were FETs and GaAs wafers (DoD, 1985, p. iii).

In short, the TAT had identified key devices and components directly related to developing such military APA radars in

the United States and placed them at the top of its list of interesting Japanese technologies. The report implied that Japanese companies were developing microwave devices and components primarily for commercial applications, such as radio astronomy receivers, direct broadcast satellites, local area networks, and collision-avoidance radars. But it also noted that Japanese developments in GaAs microwave and millimeter-wave devices and components made "broadband phased-array technology possible." (DoD, 1985, p. 3-6.)

A Brief Glimpse at Japan's New Military Radar Technologies

Indeed, the Japanese had actually offered the team a tantalizingly brief glimpse of a few impressive military electronics systems under development that drew heavily on these dual-use technologies. One of the most dramatic revelations was that JDA and several Japanese contractors were apparently well advanced in various aspects of military APA antennas and radar systems. Team members learned about several prototype APA antenna arrays under development at different locations. Japanese officials also told the team that a fire-control radar using APA technology for fighter aircraft was well advanced in the developmental process. However, the American team could find out little meaningful information about most of these programs, particularly the fire-control radar.²⁹

At one location, the Japanese showed the Americans T/R modules and an antenna array that used advanced GaAs technology. The Japanese provided some performance goals but divulged little specific technical information or test data on the prototype. The Americans could not even clearly verify the development status of the prototype or determine whether all the modules and other radar components were actually working parts or simply mock-ups. The microwave specialists on the U.S. team tried to glean specifications and performance data on the T/R modules in the prototype

²⁹This information is based on the recollections of the team leader and five other TAT participants interviewed by the author on October 13-16, 1992: Ken Ando, Thomas Hartwick, A. J. Kuno, John MacCallum, Ronald Paulson, and Barry Spielman.

antenna array and determine which Japanese electronics company had developed and manufactured the T/R modules. Again, the Japanese refused to provide any information. Some team members speculated that, given the commercial R&D they had seen at NEC and Fujitsu, the T/R modules had been made by those companies, but they could not confirm this.³⁰

The Japanese T/R modules and arrays primarily interested the two or three TAT members most familiar with U.S. developments in APA radar technology. One team member was especially surprised and impressed by the existence of Japanese prototype active antenna arrays. NRL's program to develop an APA antenna, which he headed, had not yet delivered fully operable T/R modules. Yet the Japanese appeared to have already developed entire antenna arrays populated with functional T/R modules, although it was not clear how many were mock-ups. Yet the U.S. NRL program planned to produce only a handful of module elements, and these not until 1985. Another U.S. microwave specialist who worked for a leading U.S. defense electronics firm noted that his company had only advanced to the stage of GaAs discrete devices and was just beginning its efforts to develop MMIC and active T/R modules. In short, it seemed the Japanese might possibly be years ahead of the American developmental effort in this critical military technology, especially on the system level.³¹

But because the Japanese provided little specific program or technical data and because the Americans were not permitted to examine any radars closely, U.S. radar specialists remained skeptical about the performance capabilities of the systems under development. It just did not seem plausible that the Japanese were ahead of the American efforts in this cutting-edge area of military R&D. After further contemplation and discussion with his colleagues, the U.S. microwave expert concluded that differing national system development strategies might explain the apparent Japanese lead. The available evidence suggested that the Japanese were using a lower-risk incremental system development approach in which relatively low-power T/R modules had been developed for insertion into prototype arrays. The resulting antenna array would have little useful operational capability, but would

³⁰Interviews with Barry Spielman on October 13 and 15, 1992.

³¹Interviews with Spielman, Kuno, and Ando (1992).

provide Japanese engineers with an opportunity to experiment with module fabrication and system development at a very early stage. Furthermore, the Japanese T/R modules were relatively large and used hybrid integrated circuits, although at least some MMICs seemed to have been used. The U.S. approach sought to develop much higher power T/R modules with advanced MMICs before integrating them into an antenna array and developing a prototype radar system. This difference in approach seemed to explain why the Japanese already had prototype APAs at a time when the United States was still trying to develop GaAs T/R modules.³²

Nonetheless, at least a few of the U.S. team members remained quite impressed with the apparent technical sophistication and the advanced state of development of APA radar technology, particularly of the T/R modules, as well as other military electronics systems and components they learned about on the trip, such as visible and infrared (IR) imager technology. Most had expected to see Japanese commercial applications of electronics technologies that equaled or surpassed similar efforts in the United States. Japanese work in such areas as compact laser disks and fiber-optic gyros confirmed these expectations. Yet they had not entirely expected the ambitiousness of some of the military electronics programs JDA sponsored.

Still, the majority of the TAT stuck to the conventional wisdom that commercially developed dual-use technologies owned by Japanese companies were potentially of greatest interest for U.S. defense applications. Although they had learned about the existence of some ambitious defense electronics programs conducted by TRDI, they had acquired few technical details. Given the low level of Japanese government military R&D funding and the lack of Japanese experience in developing complex and highly specialized military electronics systems, such as radars, the TAT members remained generally skeptical of pure military research projects. Most of the interesting defense-related technologies the TAT actually saw were found in either purely commercial applications or in company efforts that applied commercially developed dual-use technology owned by the private sector to defense electronics. Examples included the wide range of GaAs integrated circuits and

³²Interviews with Spielman, Kuno, and Ando (1992).

microwave and millimeter-wave devices and components being developed at many companies, as well as IR imaging TV using IR charge-coupled devices (CCDs) and other electro-optical technologies seen at Toshiba, Fujitsu, and elsewhere (DoD, 1985, pp. 2-9, 2-13).

However, the TAT members remained pessimistic about actually acquiring Japanese commercially developed dual-use technology for application to U.S. defense programs. As the TAT pointed out in its findings and conclusions, "electro-optic and millimeter-wave technology exchange between the United States and Japan presents distinct challenges" because "much of the technology of interest to the United States is in the Japanese industrial sector." Acquiring commercial dual-use technology would "necessitate extensive cooperation between the U.S. government and the Government of Japan to effectively interact with individual Japanese companies." (DoD, 1985, p. 3-1.) MITI's cooperation was crucial, because that ministry "is in charge of coordinating R&D policies for the technologies owned by the commercial sector and in regulating overseas technology transfer of them." Although the 1983 Exchange of Notes provided "a new opportunity for significant technology exchange," the TAT cautioned that "substantial follow-up by DoD and U.S. industry is necessary if full advantage is to be taken of this new opportunity." (DoD, 1985, p. 3-6.)

Indeed, although JDA officials had seemed reasonably willing to assist the American effort, they had made it clear to the TAT that they could not control Japanese industry and that they could not guarantee that Japanese firms would be willing to transfer technology to the United States. The problem, they explained, was gaining MITI approval and cooperation. The meetings with MITI officials, however, revealed a tremendous reluctance to cooperate with DoD because of the domestic political sensitivities about arms exports.³³ Direct discussions with the Japanese companies had not been any more encouraging in this respect. One team member recalls that the private firms most directly and heavily engaged in defense-electronics R&D, such as MELCO, were the least willing to share technical details with the American visitors.³⁴

³³Interview, MacCallum (1992).

³⁴Interview, Spielman (1992).

Taking a Second Look at Japanese Defense-Related Technologies

With the negotiations for the implementation arrangement stalled, and the rather discouraging report from the TAT on the prospects for acquiring dual-use commercial technology, DoD sought new strategies to counter what was increasingly seen as foot-dragging and dissimulation by the Japanese government on the issue of defense-related technology transfer. Acquiring dual-use commercially owned technology on an industry-to-industry basis seemed to be increasingly unlikely. Consequently, the Pentagon decided to redouble its efforts to acquire Japanese military technologies by way of the JMTC structure, even though no implementation arrangement had yet been finalized. After all, some TAT members had thought there might be something of interest in Japanese military R&D, particularly in the area of APA radar and CCDs. Even without an implementation agreement, Pentagon officials hoped that a formal government request strongly backed by one of the U.S. services for a specific military technology would advance the process and help establish a precedent for actual technology transfer.

Yet this new approach also proved extremely difficult to implement. The task of identifying a specific JDA weapon system program that would interest U.S. industry and one of the U.S. military services proved much harder than expected. The services were not particularly interested in military technology collaboration with JDA—or with other allied countries, for that matter. The findings of the DSB Task Force and the first TAT had generally reinforced the view that Japanese military technologies remained far behind those of the United States. The lack of interest had been made abundantly clear when the first TAT leader briefed the results of the Japan trip around the Pentagon and throughout the U.S. military R&D communities. Furthermore, U.S. defense contractors also seemed remarkably uninterested in Japanese military R&D.³⁵

The problem was made much more difficult because Japanese government and industry had not generally been forthcoming to U.S. officials about many of their current military R&D efforts. At

³⁵Interview, MacCallum (1992).

least some TAT members suspected that they had been given details only about insignificant or older military R&D programs, such as the ASM-1 antiship missile, in which the U.S. services had little interest. But information on more-advanced military technologies, such as those that applied to APA fire-control radar and other military microwave systems, was generally withheld. Thus, there was little detailed information on such a radar to provide the services or U.S. industry that might overcome their skepticism.³⁶

Consequently, DoD sought to arrange a follow-up visit to Japan by the same TAT on electro-optics and millimeter-wave and microwave technology to try to fill in some of the missing information from the first trip, to visit several additional Japanese electronics firms, and to brief Japanese officials on the TAT's initial findings. The Pentagon's OUSDRE also moved ahead on establishing new teams of experts on other technologies for future assessment visits. The Japanese government approved a return visit of the first TAT for April 1985. During the second trip, however, team members met an unbreachable wall of silence at MELCO and elsewhere when they inquired further about the development of an APA fire-control radar and other ongoing military applications of Japanese dual-use technologies sponsored by the government.

On returning from Japan from the second visit, TAT members wrote an extensive new trip report on their findings from both trips that DoD distributed widely in government and industry circles.³⁷ JDA translated the report and distributed it in Japan. The Pentagon held at least one major meeting with senior U.S. industry representatives to discuss the TAT findings and encourage industry-to-industry contacts with Japanese firms. Government and industry technology experts were also polled on their principal technology areas of interest for future collaboration. Industry respondents showed some modest interest in finding out more about Japanese MMICs, GaAs materials and devices, and IR imagers. However, most U.S. companies, particularly the larger defense electronics contractors, expressed little interest in actual Japanese military subsystem developments, primarily because they believed they were far more advanced in military technology applications than the Japanese. U.S. government officials briefed the findings

³⁶Interviews, various TAT members (1992).

³⁷An extensive press account of the trip findings can be found in Klass (1985).

and industry responses to the U.S.-Japan S&TF in January 1986. The only result of this effort, however, was an S&TF recommendation for a third TAT visit to Japan, later arranged for August 1986 (OUSDA, 1987, pp. 1-3 to 1-4).

Going After the Keiko Surface-to-Air Missile

The Pentagon strategy to target technology applied to a specific Japanese military R&D program ultimately made some progress but in the end produced only meager results. DoD was eventually able to elicit U.S. service interest in one JDA military R&D program about which information had been made available by the Japanese. One of the more interesting applications of dual-use technology to a military system the TAT had seen in Japan was a infrared homing target seeker for guided missiles funded by TRDI (Klass, 1985). In 1979, the Japanese government had authorized the indigenous development of a man-portable surface-to-air missile (SAM), designated the SAM-X Keiko. The target-seeker head for the missile employed infrared CCD technology. Japanese authorities reportedly claimed this technology was superior to that on similar U.S. missiles. The Keiko seeker-head technology had been directly derived from commercial low-level IR detector devices used in fire alarms and CCDs for video cameras and copying machines under development at Toshiba, MELCO, and Fujitsu.³⁸ However, JDA funded and TRDI conducted initial development of the Keiko missile and seeker head in 1979 and 1980, later handing development over to Toshiba. Therefore, JDA owned the missile seeker technology, bringing it clearly within the definition for military technology transfer established by the Japanese in the Exchange of Notes.

Most important from the DoD perspective, this technology actually elicited some interest from one of the services. The U.S. Army ultimately agreed to participate in a formal request for the technology. According to press reports, the Japanese MOFA approved transfer of Keiko seeker technology to the United States in June 1985, immediately following the second TAT visit.³⁹ But

³⁸"The Electronics Revolution and the Ban on War Materials" (1982), p. 11; Yoshiro (1986), p. 239.

³⁹"Japan Has Agreed to Transfer Missile Seeker Technology" (1985).

actual transfer of this technology required JMTC approval, and negotiators still had not been able to agree on the implementation arrangement called for in the Exchange of Notes. As discussed earlier, these negotiations dragged on for an additional six months until agreement was finally reached in December 1985.

Yet approval of the detailed arrangements did not open the doors to Japanese technology. It took another nine months for the JMTC to finally approve the Keiko request. Later allegations of Japanese gouging on the price to be paid for R&D recoupment on the technology, and U.S. outrage over the revelation that Toshiba had illegally transferred defense-related technology to the Soviet Union, ultimately led to a collapse of the Keiko deal.

While negotiations over the Keiko were still under way, Ishikawajima Harima Heavy Industries (IHI) agreed to transfer shipbuilding and repair know-how to the Pennsylvania Shipyards for auxiliary tankers and to the U.S. Navy's Philadelphia shipyard in two separate arrangements. Although these transfers actually took place, they had required major U.S. concessions during the negotiations for transfer. The IHI technology was clearly commercial in origin, so IHI had agreed to transfer the technology on a commercial basis. U.S. officials, therefore, argued that the transfer request should not have to be channeled through the JMTC and subjected to review and approval by the bureaucracies of MITI, MOFA, and JDA, whose representatives all sat on the JMTC. MITI officials countered that, since the technology would be applied to military programs, the transfer had to be approved by the Japanese section of the JMTC. U.S. negotiators ultimately acquiesced to the Japanese position to get an agreement but worried that a new precedent had been established about technology *application* and origin that might further complicate and delay technology transfer in the future (Rubinstein, 1987, p. 46).

PENTAGON FRUSTRATION ON THE EVE OF FS-X

At the end of 1985, after nearly eight years of American initiatives to acquire Japanese technology for U.S. military applications, Pentagon officials had little to show for their efforts. Almost five years had been required to convince the Japanese to agree in principle to exempt the United States from prohibitions against the transfer of defense-related technologies and to sign a detailed im-

plementation arrangement. Originally, the Pentagon had focused on Japanese commercially developed dual-use technologies, but resistance from MITI and Japanese industry had dashed hopes for extensive technology transfer on an industry-to-industry basis. DoD then took aim at acquiring Japanese government-owned military technology. However, government and industry officials remained reluctant to provide detailed information on their current military R&D efforts. Furthermore, skepticism about the potential value of Japanese military technologies for American defense applications remained widespread in the U.S. military R&D community.

Nonetheless, Pentagon officials also came to realize how little American experts knew about current Japanese military R&D developments. After sending TATs to Japan, some U.S. experts began to revise their views about the conventional wisdom on Japanese military technology, even though the Japanese military R&D establishment had provided little information on their cutting-edge activities. This was particularly true in the case of military APA radars. However, the large U.S. defense contractors and the service laboratories did little to follow up on these military R&D efforts, particularly since the Japanese became even more secretive about them in latter TAT visits. Little was done in a formal way to find out any more about the TRDI program for an APA fighter radar.⁴⁰

All this began to change, however, by the second half of 1986, but within a context completely separate from the formal DoD ef-

⁴⁰One well-informed U.S. industry expert summed up the whole frustrating experience of negotiating with the Japanese over technology reciprocity as follows (letter to the author, 1994):

- a. The Japanese seek protracted "discussions" to delay/dilute the achievement of any specific objective.
- b. If the discussions eventually lead to some type of policy statement, this leads to protracted discussions of (generally irrelevant) details which generally evade the true purpose/objective of the matter.
- c. The negotiations/agreements are generally with the wrong people (that is, not the people empowered to affect a real solution).
- d. The agreements generally are not 'enforceable'—the U.S.G. and U.S. industry have no insight into Japanese technology development, and, if the Japanese are not forthcoming, have no recourse to compel the Japanese to cooperate.

fort to gain access to Japanese defense-related technologies. This new context emerged out of a much larger struggle conducted by different DoD offices and two U.S. fighter aircraft prime contractors to stop the JDA from launching the development of a world-class indigenous fighter aircraft called the FS-X and referred to by some as the Rising Sun fighter. During this struggle, the Japanese side began revealing more information about its APA radar development and other indigenous military technologies to counter American pressure to buy or license-produce an existing U.S. fighter. Initially, these Japanese indigenous technology developments remained peripheral to the central issues in the dispute. Yet, by 1989, the question of U.S. access to the Japanese technologies, particularly those associated with APA radar and composite materials, became the central theme of an acrimonious public dispute between the two countries over the FS-X fighter that drew its force from profound tensions over trade, technology leadership, and future military capabilities. It is to the background of that larger dispute that we now turn.

**JAPAN'S POSTWAR QUEST FOR
A NATIONAL FIGHTER**

INTRODUCTION

In 1985, concern dramatically increased in U.S. aerospace industry and Pentagon circles that the Japanese government was about to launch the full-scale development of its first world-class national fighter aircraft since the Second World War. The greatest sense of urgency seems to have been expressed by the two leading prime contractors for American fighter aircraft, General Dynamics and McDonnell-Douglas. There was of course a major economic component to these concerns. U.S. industry feared losing the lucrative Japanese fighter market, which it had almost totally dominated since the end of World War II through Japanese licensed production of U.S. fighters. For the longer term, U.S. defense companies shuddered at the prospect of having to compete on the global market someday against a resurrected Japanese military aerospace industry. After savaging the U.S. automobile and consumer electronics industries in global competition and building up huge trade surpluses with the United States, Japan now seemed poised to launch an assault on one of the last high-technology bastions where U.S. predominance remained unquestioned, and which consistently produced trade surpluses with both Japan and the rest of the globe.

Yet economic and trade issues were hardly the only areas of concern to U.S. policymakers when confronted with the prospect of an indigenous Japanese military aircraft industry. Though rarely openly and clearly stated, both sides recognized the potential strategic military and political implications of such a development. An autonomous Japanese military aerospace capability could be

seen as both a major contributor to, and a reflection of, a fundamental shift in the strategic relationship between the United States and Japan. For 40 years, Japan had remained the dutiful junior partner in the U.S.-Japan security relationship, providing bases and modest military forces to help defend Japan and supplement U.S. forces in the northwest Pacific region as part of America's global military strategy against the Soviet Union and the People's Republic of China. At the same time, Japan's economic miracle was transforming the country into one of the world's foremost economic and technological superpowers. Yet the SDF remained relatively small, almost entirely defensive in nature, and configured in a way that precluded effective autonomous operations outside of basic homeland defense. The mission specialization and operational integration of the SDF with U.S. regional forces actually increased significantly beginning in the late 1970s as the Pentagon pushed for greater burden-sharing and the division of roles and missions in the Pacific theater (Levin, Lorell, and Alexander, 1993).

Western observers have often maintained that Japanese companies, particularly aerospace contractors, have pursued weapon development primarily for commercial reasons as a way to develop commercially useful technologies or as a profitable way to extend commercially developed technologies to lucrative defense contracts from the government. However, considerations of national sovereignty, pride, and patriotism have also clearly been important motivating factors for both Japanese industry and the government. One of the key elements of Japanese military dependency on the United States is Japan's lack of a full-spectrum indigenous military industrial base. Greater autonomy in arms production had been a key goal of some sectors within Japanese industry and the government as far back as the 1950s. A central objective was to enhance Japanese sovereignty and gain greater independence of action vis-à-vis the United States and other foreign powers. As a policy paper of the Defense Production Committee of the *Keidanren* (the Federation of Japanese Economic Organizations) noted in 1974 (quoted in M. Green, 1990, p. 9),

[A]t the very least, [a policy of relying on imports of weapons] prevents a nation from adopting hostile activities towards the supplier of its weapons. And even if one accepts that a country would

not go as far as taking such hostile action, that country would still be unable to take action which opposes the intentions of its supplier.

Maximum indigenous procurement of SDF weapons became official policy when Yasuhiro Nakasone took over the directorship of the JDA in 1970 (M. Green, 1990, pp. 24–26; Drifte, 1986, pp. 12–13). Growing doubts about U.S. reliability following the U.S. policy announcement of “Vietnamization” of the war in Southeast Asia had led Nakasone to order a reassessment of Japanese defense policy. The result was the pronouncement of a new weapon procurement policy based on indigenous development and production. JDA's new “Basic Policy Towards Defense Production” proclaimed that “the development and production of military equipment will be limited to Japanese industries as a matter of principle.” (Quoted in M. Green, 1990, p. 25.)

Yet, well before the Nakasone policy, sectors within industry and government had been pushing for greater autonomous defense industry capability. The general trend in Japanese military procurement since World War II has been toward increasing domestic development and production, but the progress has been uneven. Throughout most of the postwar era, significant sectors of the Japanese defense industry have remained heavily dependent on U.S. and other foreign technology. Nonetheless, substantial success had already been registered in the quest for an autonomous defense industrial base by the end of the 1970s.

This chapter reviews the postwar efforts of Japanese industry and military officials to rebuild a more independent aerospace defense industrial sector, culminating with the dramatic success achieved in mid-1985 of winning tentative government approval for indigenous development of Japan's first world-class fighter aircraft since the Second World War.

DEVELOPMENT OF JAPAN'S POSTWAR DEFENSE INDUSTRY

First Steps

The U.S. occupation authorities formally approved the rebirth of Japanese domestic armaments industry in 1952 during the Ko-

rean War. Within a decade, Japanese companies were designing, developing, and producing many of the key weapons, combat vehicles, and combat ships used by the Ground Self-Defense Force (GSDF) and the Maritime Self-Defense Force (MSDF).

By the end of the 1960s, a significant percentage of the GSDF's inventory of main battle tanks (MBTs) was made up of the indigenous Type 61 MBT produced by Mitsubishi Heavy Industries (MHI), first introduced in 1962 at a time when only a handful of countries in the world designed and produced their own tanks.¹ Other major weapon systems and combat vehicles, such as the Type 60 self-propelled 106-mm recoilless rifle and Type 60 armored personnel carrier (APC), continued entering into service throughout the 1960s. Japanese-developed high-technology land weapons of this era also included relatively sophisticated missile systems, such as the Type 64 antitank guided missile (IISS, 1964, p. 30; IISS, 1970, p. 64; IISS, 1971, p. 47). In the late 1960s and early 1970s, Japan developed a second generation of army combat systems, such as the Type 74 tank and Type 73 APC. Tactical missiles of that decade included the Type 30 SAM and the KAM-9 antitank guided weapon.

By the end of the 1950s, Japanese industry was already producing virtually all combat and support ships purchased by the MSDF. Japanese shipyards also began designing and developing diesel attack submarines. However, MSDF surface combatants remained largely dependent on foreign sources for the military electronics, guns, and tactical missiles that equipped the Japanese-built hulls. Nonetheless, in the 1970s, the MSDF began the process of transitioning to indigenously designed and developed surveillance radars, fire-control systems, and sonars (Drifte, 1986, p. 43).²

By contrast, the development of indigenous R&D capabilities for military aircraft and their major subsystems made less progress through the 1970s than did army fighting vehicles and navy ships. Furthermore, the history of postwar Japanese military aircraft de-

¹As late as 1971, only nine countries—the United States, the Soviet Union, the United Kingdom, the Federal Republic of Germany, France, Sweden, Switzerland, India, and Japan—designed, developed, and manufactured their own tanks. India's tank was a modified version of a British tank.

²For a detailed analysis of foreign versus domestic subsystems fitted on Japanese surface combatants, see Alexander (1993), pp. 56–59.

velopment is more complicated because of the variety of actors and differing motivations and policies involved. Since the 1950s, all fighter aircraft deployed by the Air Self-Defense Force (ASDF)—with the exception of the less capable Mitsubishi F-1 support fighter—have been American-designed and -developed aircraft manufactured in Japan under license. Except for a handful of training aircraft and small transports, virtually all fixed-wing and rotary-wing combat and support aircraft of all other types deployed by all three of the Japanese military services since the Second World War were designed and developed in the United States. Furthermore, most of the tactical missiles used by all three Japanese services have historically been of American origin. One analyst has estimated that, as late as 1990, the Japanese-designed and -developed systems deployed by the ASDF made up only 21 percent of the combat aircraft, 33 percent of the transport aircraft, 49 percent of the trainer aircraft, and 25 percent of the SAMs in the active inventory. As a comparison, in that same year, all GSDF armored fighting vehicles were of Japanese origin (Alexander, 1993, p. 61).

One explanation for this anomaly is that combat aircraft—and particularly high-performance fighters—are among the most expensive, complex, and difficult weapon systems to develop. Further, the cost, time, and commitment of resources required to develop a first-line fighter have continued to escalate dramatically since the 1950s. The result is that very few countries remained major developers of fighter aircraft after the Second World War, and the number of members in this elite club continued to shrink over the next several decades. By the end of the 1960s, the only countries in the world besides the two superpowers that supported full-spectrum military aerospace industries and developed their own national first-line fighters were the United Kingdom, France, and Sweden.³ In 1964, Britain's newly elected Labour government canceled the TSR.2 fighter-bomber and several other fighter

³The People's Republic of China developed a large military aerospace industry that manufactured thousands of fighters. (The history and future of China's air force are discussed in Allen, Krumel, and Pollack, 1995.) These fighters, however, were copies or modifications of Soviet designs. India developed the disappointing HF-24 Marut fighter in the 1960s with considerable help from a German design team. Other countries such as Egypt toyed unsuccessfully with fighter development during the 1960s.

development programs, ending national development of first-line fighter aircraft in the United Kingdom.⁴ Thereafter, Britain modified U.S. fighters or developed fighter-attack aircraft collaboratively with Germany and Italy or with France. Sweden continued indigenous fighter development, but its fighters remained heavily dependent on American or other foreign technology, particularly for engines (see Dorfer, 1973). Indeed, France remained the only country other than the two superpowers that continued to develop front-line fighters on a purely national basis, relying largely on indigenous technology and R&D. Yet even France turned increasingly to international collaboration for other combat aircraft in the 1960s.⁵

Thus, Japan's failure to develop indigenous fighter aircraft and other major aerospace weapon systems in the 1950s and 1960s is not difficult to understand. In the words of Richard Samuels and Benjamin Whipple (1989, p. 286), "the amount typically spent by the United States simply for fighter-related R&D has historically exceeded the sales of the entire Japanese aerospace industry." Given the high costs and technical difficulty of developing high-performance fighters, the relatively limited resources Japan has historically committed to military R&D and basic aeronautical research, and the widespread antimilitary sentiment of the Japanese public, it is not surprising that Japan chose mainly to license-produce U.S. designs for the ASDF through the 1980s. What is perhaps more surprising is the substantial progress toward a national military aerospace capability Japan had made by the end of the 1970s and the Japanese decision in the early 1980s to develop a world-class indigenous fighter.

⁴The United Kingdom continued development the Harrier vertical/short take-off and landing (VSTOL) attack aircraft under development since the late 1950s and the Hawk jet trainer. See Wood (1975).

⁵The French air force and navy fighter inventories in the 1960s and 1970s relied heavily on the Dassault Mirage III/5 and Etendard series. However, France collaboratively developed its primary strike/attack aircraft, the Jaguar, with the United Kingdom, and its tactical transport (C-160 Transall) and maritime patrol aircraft (Atlantic) with Germany and other European countries. See Kolodziej (1987).

Reviving the Postwar Military Aircraft Industry

The failure to develop a postwar Japanese fighter was not for want of trying. From the early 1950s, business leaders representing Japan's former wartime aircraft industries lobbied hard for the resurrection of the military aircraft sector (M. Green, 1990, p. 13). Japan had boasted a large and technically advanced military aircraft industry during World War II that produced some of the leading fighters of the war, such as the famous Mitsubishi Zero, the Kawasaki Hien, and the Nakajima (later Fuji) Hayabusa. At the height of the war, Japanese industry output stood at 25,000 airframes and 40,000 engines a year (Mowery and Rosenberg, 1985, p. 9). In the years immediately following the war, the occupation authorities forbade Japanese development and production of military aircraft. The aircraft industry reemerged during the Korean War with American encouragement and funding. The end of the occupation regime in 1952 effectively removed the ban on military R&D.

MITI strongly supported industry's push to revive the arms industries in the 1950s through domestic R&D and procurement. MITI policy, however, was motivated by a wider economic agenda in support of developing high-technology industry and laying the foundations for a commercial aerospace industry. The MOF and the precursor of the JDA often opposed MITI and industry because of budgetary concerns and the desire for cost-effective military procurement. Without American encouragement and financial support, MITI and industry would have probably failed in their effort. Instead, the result was a compromise (M. Green, 1990, pp. 15-17). To develop manufacturing capability and provide the ASDF with first-rate aircraft, the government in 1955 selected the North American F-86F jet fighter for licensed production by Mitsubishi and the Lockheed T-33A jet trainer (a variant of the F-80 fighter) for licensed production by Kawasaki. To help develop national R&D capability, the government supported the indigenous development of the T-1 jet trainer and its engine by Fuji and IHI. This aircraft, which first flew in 1958 with a British engine, was closely patterned after the American F-86. Later versions were equipped with the nationally developed IHI J3 turbojet engine. In the early

1960s, Mitsubishi attempted unsuccessfully to sell the T-1 to the Royal Australian Air Force (Munson, 1971, pp. 124–125).

In the late 1950s, Mitsubishi hoped to develop an indigenous follow-on fighter based on experience gained from licensed production of the F-86. MITI opposed this course, believing that Japan's military aircraft capabilities had not yet progressed sufficiently to support such a demanding project. In 1959, the government selected the Lockheed F-104 Starfighter for licensed production to succeed the F-86. However, MITI supported the passage of the second Aircraft Promotion Law in 1958 that called for developing an indigenous military industry and explicitly linked that development to promoting a commercial aircraft industry.

Fighters Versus Commercial Aircraft

It is useful at this point to interrupt the account of the development of the Japanese military aircraft industry briefly to examine the question of the linkage between fighter aircraft R&D and the development of a commercial aircraft industry. In the late 1980s, during the height of the FS-X controversy in the United States, American critics of the program routinely asserted that the primary Japanese motivation for developing FS-X was to acquire U.S. aerospace technology to help build a commercial aircraft industry. The fact that MITI explicitly articulated this link as far back as the 1950s seems to confirm this assertion.

A variety of factors, however, raise serious questions about the validity of this assertion. Most American industry observers would agree with the conclusion of Mowery and Rosenberg (1985, p. 10) that not much of the technology employed in fighter aircraft can be "readily transferred to applications in commercial aircraft." Commercial airliners are large, relatively slow transport aircraft optimized for safe, low-cost, and efficient operation. Fighters are small, densely packed aircraft optimized for high speed, maneuverability, and effective delivery of air-to-air and air-to-ground munitions. Broad generic technologies and processes are applicable to both types of aircraft. However, the performance and technological demands for developing modern fighters far exceed those of commercial aircraft in design, integration, materials, avionics (radars

and other electronics), engines, and most other subsystems. In short, the relationship between developing fighters and airliners is roughly comparable to that between developing a high-performance sports car and a city bus. Indeed, recent research suggests that there is an inverse relationship in the U.S. aerospace industry since World War II between success in developing advanced fighter aircraft and success in commercial transport aircraft.⁶

MITI's and industry's actions in the 1960s reveal a clear recognition of these differences. Development of military and commercial aircraft capabilities proceeded on separate tracks. Licensed production of the F-104 and the further improvement of the T-1 were the means by which industry could acquire technology and experience relating to high-performance fighter aircraft. But MITI established a separate and much more direct avenue for civil aircraft development. The second Aircraft Promotion Law provided funding and established a special consortium of the leading aircraft companies—Mitsubishi, Kawasaki, Fuji, Showa Aircraft, Japan Aircraft, and Shin Meiwa—to develop a medium commercial transport. The government financed over one-half of the R&D costs. The resulting aircraft, the twin turboprop YS-11, proved to be a technological success but a commercial failure. Foreign sales did not meet expectations; ultimately, less than 200 of the aircraft were built. Nonetheless, the YS-11 development effort provided Japanese industry with valuable experience much more directly related to developing future commercial transports than was work on the F-104 and T-1 (Lorell, Sanders, and Leveau, forthcoming).

The link between civil airliners and large military aircraft, such as tactical transports and maritime aircraft, is, of course, much closer than with fighters. In the 1950s, the U.S. development of these types of aircraft, as well as of large jet bombers, such as the B-47 and B-52, contributed to the emergence of advanced jet

⁶For example, Convair (later General Dynamics) was a leading fighter developer from the 1950s through the 1980s. Convair made a strong bid for commercial jet transport leadership in the 1950s but failed and never tried again. North American was never a key player in large commercial transports but was a prominent fighter developer well into the 1960s. Boeing became the world's most successful developer and producer of large airliners but did not develop a fighter aircraft after the 1930s until it became involved in the USAF F-22 Advanced Tactical Fighter (ATF) program dominated by Lockheed in the 1980s. See Lorell, Sanders, and Leveau (forthcoming).

airliners like the DC-8 and the Boeing 707.⁷ A small licensed-production run of Lockheed P-2 Neptune maritime patrol aircraft by Kawasaki authorized in the 1950s was far more relevant to the development of civilian transport aircraft than licensed production of U.S. fighters. Kawasaki gained further experience by developing a modified version of the P-2 in the early 1960s that incorporated a stretched fuselage and turboprop engines.

Interestingly, the Japanese actually moved in the opposite direction from an indigenous civilian transport development program to a military program, rather than vice versa. The YS-11 made its first flight in 1962 and entered production two years later. The same consortium established to design and develop the YS-11, the Nihon Aircraft Manufacturing Company, began design work on the C-1 medium military jet transport in 1966. Development was competed by Mitsubishi and Kawasaki in the early 1970s. This aircraft achieved only modest operational success and was purchased in very small numbers—about 40 aircraft—by the ASDF (Gunston, 1981, p. 220). The C-1 proved so inadequate in meeting the operational needs of the air force that the ASDF finally convinced the government to purchase Lockheed C-130 Hercules transports from the United States in the early 1980s, despite strenuous objections from MITI and industry.⁸ However, the C-1 provided Japanese industry with valuable experience in developing a larger jet transport aircraft.

Japanese industry understood that by far the most direct means of gaining experience with large commercial transports was to develop one. With the high expense and commercial failure of the YS-11, MITI's strategy shifted toward a policy of collaboration with leading U.S. manufacturers of airliners to develop Japan's civil aircraft capabilities further. Japanese firms were encouraged to establish subcontractor relationships with U.S. companies in the 1960s for this purpose. With MITI guidance and support, Japanese firms formed a new consortium in 1973 and established a long-term collaborative relationship with Boeing. The consortium began joint design and development work with Boeing on the YX, which

⁷Boeing began development of the 707 in the early 1950s as a private venture with the intention of producing an aircraft that could serve as both a civil transport and a military aerial tanker.

⁸"Japan Increasing Defense Spending Despite Decline" (1981), p. 67.

later became the B.767 airliner (Mowery and Rosenberg, 1985, pp. 10-11).

Japanese companies accepted the new MITI strategy of collaboration and gave up any pretense for the time being of developing a large airliner on a purely national basis. The enormous expense and experience required to design, develop, produce, and support modern long-haul airliners were rapidly growing beyond the capabilities of single companies, or even countries. The French and British industries stopped developing large commercial transports on a national basis in the 1960s, turning to collaboration with each other and other European countries to develop the next generation of jumbo jets. Even U.S. companies began to falter in the face of the huge costs necessary to develop wide-body transports. Lockheed withdrew entirely from the civil market in the early 1970s following the massive losses experienced on its L-1011. Boeing and McDonnell-Douglas increasingly turned to foreign collaborators to help share development costs and ensure overseas markets.

THE PUSH TOWARD INDIGENOUS MILITARY AIRCRAFT IN THE 1970s

Thus, Japanese companies accepted the need for international collaboration to acquire experience in commercial transports. On the military side, however, they continued to press with considerable MITI support for developing a national fighter R&D capability. Industry achieved a major success in 1966 when the government approved the development of Japan's first supersonic jet trainer, the TX (later the T-2) as the next step toward a Japanese fighter. Japan, however, continued to license-produce U.S. systems for its first-line fighters. Japanese indigenous capability was not yet adequate for national fighter development. Further, by the late 1960s, the first indications of U.S. pressure on trade and economic issues contributed to the Japanese decision to license-produce another U.S. fighter for the ASDF. In response to U.S. complaints, the MOF pressured the JDA to increase procurement of U.S. systems (M. Green, 1990, p. 23). In April 1969, the government signed an agreement to license-produce the McDonnell-Douglas F-4E Phantom for the ASDF. Table 3.1 shows U.S. military aircraft license-produced in Japan.

Table 3.1**U.S. Military Aircraft Produced Under License in Japan**

Fighters	Helicopters	Other
North American F-86F	Boeing KV-107	Lockheed T-33A
Lockheed F-104J	Sikorsky S-61A	Lockheed P-2J
McDonnell-Douglas F-4EJ	Bell UH-1B/H	Lockheed P-3C
McDonnell-Douglas F-15J	Sikorsky SH-60	
	Boeing CH-47	
	Bell AH-1S	
	Hughes OH-6	

The appointment of Yasuhiro Nakasone in 1970 to head the JDA and the promulgation of the new "Basic Policy Towards Defense Production" emphasizing indigenous production revived industry's hopes for developing a Japanese fighter and a broader-based military aerospace capability (Tables 3.2 and 3.3). The procurement outline for the new defense plan under Nakasone's guidance called for a 350-percent increase in R&D funding to support indigenous development of the HX helicopter; the PXL maritime patrol aircraft; an airborne early warning (AEW) aircraft; and, most important, the FST-2 (later the F-1), a ground-support fighter based on the T-2 trainer airframe. Political developments, however, led to a drastic scaling down of proposed military R&D funding. At one point in 1972, it appeared that all the proposed indigenous projects might be canceled because of funding cuts and because of U.S. pressure to purchase American systems. The MOF fought particularly hard for canceling T-2 production and FST-2 R&D in favor of purchasing U.S. Northrop F-5E fighters as American pressure on trade issues increased (M. Green, 1990, pp. 27-30).

The outcome of this dispute offers some insight into the likely motivations and priorities of the various actors. Industry and the JDA rallied against intense opposition from other government agencies to save at least the most important of the threatened projects: the T-2 and the FST-2. These two projects represented critical incremental steps toward national development of a first-line fighter. The T-2 and FST-2 programs were ultimately spared, despite U.S. pressure to buy the F-5E. Japanese industry then lobbied MITI and other agencies hard for the PXL, emphasizing the broader technological and commercial benefits that would accrue to

Table 3.2
Japanese Indigenous Military Aircraft

Fighters	Jet Trainers	Other
Mitsubishi F-1	Fuji T-1A Mitsubishi T-2 Kawasaki T-4	Shin Meiwa US-1 Kawasaki C-1

the economy as a whole from development of a large maritime patrol aircraft. MITI, however, rejected these arguments in favor of purchasing a U.S. aircraft to help reduce growing trade frictions with America. Ultimately, the PXL, as well as the AEW aircraft program, were shelved, replaced by licensed production of the Lockheed P-3C Orion. Interestingly, MITI had been willing to drop support for the two programs—PXL and an AEW aircraft—that would most directly contribute to the development of commercial transport capabilities. Yet instead of approving these dual-use R&D efforts, the government ultimately gave the green light to the T-2 and FST-2, so necessary for the future development of a Japanese fighter, despite intense opposition from the MOF and the United States (M. Green, 1990, pp. 31–37).

With the approval of these two programs, the political and technological momentum toward indigenous fighter development continued to grow through the 1970s. Government authorization for the Mitsubishi F-1 (FST-2) support fighter in 1972 marked a fundamental turning point in Japanese industry's quest to establish an indigenous fighter capability. The F-1 program established an important psychological and political precedent of Japan developing its own high-performance supersonic fighter aircraft. It also provided an invaluable learning experience for industry in the enormously complex process of developing a modern fighter.

The F-1 has generally been dismissed by Western observers as a derivative design providing only modest combat capability.⁹ But Japanese industry viewed this modest fighter primarily as a learn-

⁹According to one observer (Chinworth, 1992, p. 101):

Japan's only combat aircraft, the F-1, was a T-2 derivative that was obsolete from the day it was deployed. Too small to carry anything but minimum ordnance, the aircraft was also slow, cumbersome to fly, and lacked maneuverability for air-to-air combat.

Table 3.3
Major Japanese Modification Programs and
Test Aircraft

Modifications	Test Aircraft
F-4E <i>Jkai</i>	Mitsubishi T-2 CVV
UH-60	Kawasaki C-1 STOL

ing experience (Tabata, 1983). Mitsubishi had wisely selected an incremental strategy in trying to catch up with the world's leaders in fighter development that reduced both political and technological risk. This strategy entailed drawing heavily on foreign experience and moving by stages from airframe development of an advanced trainer to the difficult process of integrating military avionics and weapon systems for a fighter using the same airframe.

The T-2/F-1 airframe bears a remarkable resemblance to the Anglo-French SEPECAT¹⁰ Jaguar, which began development a few years before the T-2. The Jaguar served as an excellent model for the Japanese, because it also was originally conceived as an advanced trainer, later evolving into a ground-attack fighter. The Japanese aircraft uses the same engine as the Jaguar, the Rolls-Royce/Turbomeca Ardour. Mitsubishi worked closely with Rolls-Royce on design of the T-2/F-1 engine bay and integration of the Ardour into the airframe.¹¹ Undoubtedly, Mitsubishi received other forms of assistance in design and integration. The first flight of the T-2 prototype took place in mid-1971. Soon thereafter, work began on militarizing the trainer into the F-1 fighter. The F-1 is equipped with a relatively basic ranging radar, and most of the other avionics are foreign imports, such as the Ferranti inertial navigation system (INS). Yet Japanese industry gained invaluable experience by integrating these systems. When the first production F-1 flew in mid-1977, Japan could proudly claim to have joined the elite club of nations that developed their own fighters.

¹⁰SEPECAT is the acronym for the Société Européenne de Production de l'Avion, École Combat et Appui Tactique, a consortium formed between British Aerospace and Breguet Aviation in 1966. Breguet later merged with Avions Marcel Dassault.

¹¹Interview, senior Mitsubishi engineer, June 1992.

But neither Japanese industry nor the ASDF pilots who flew the F-1 had any illusions that Japan had now entered the first rank of developers of tactical fighter aircraft. Japanese industry did not yet possess the technological expertise and experience to offer a credible indigenous alternative for the next first-line fighter for the ASDF, which the air force was already actively seeking by the early 1970s when the F-1 was still under development. Thus, in 1977, the Japanese government signed an agreement with the United States to license-produce the McDonnell-Douglas F-15 Eagle, the world's most advanced operational tactical fighter. This decision came after a lengthy evaluation of at least 13 potential candidates beginning in the early 1970s. The selection of an American aircraft had in part been a response to mounting trade friction with the United States and U.S. insistence that Japan buy American defense systems for greater interoperability with U.S. forces. This agreement appeared to mean continued dependence on the United States for another generation of fighter aircraft for the ASDF (M. Green, 1990, p. 37).

INCEPTION OF THE RISING SUN FIGHTER

Japanese industry and its allies at TRDI, JDA, and MITI responded to the decisions to license-produce the F-15 by developing a careful strategy to gain government approval for a future fighter requirement and replacement schedule that would enhance the rationale for indigenous development of a first-line fighter and provide industry with the necessary time for fully establishing its technological credibility. The goal was to build on the experience gained with the T-2/F-1 development and licensed production of the F-15 to produce a truly world-class national fighter R&D capability.

MHI began preliminary design studies on an all-new indigenous fighter in the mid-1970s after the completion of the F-1 design effort. This time, MHI clearly sought to develop a high-performance air-superiority fighter rather than a lower-capability support fighter like the F-1. By 1980, a dedicated design and engineering team had been assembled that began assessing various design configurations for what was then known as the FX fighter through extensive testing of models in the wind tunnels at the MHI Nagoya facilities near the site where F-15 production was about to

begin.¹² The problem for industry and TRDI was how to sell such a high-cost, lengthy, and technologically risky fighter development program to the government.

Industry needed to develop a solid rationale for its proposal for developing the high-performance FX fighter based on supportable ASDF military requirements for an economically viable number of fighters, with a procurement schedule that permitted adequate time to conduct full-scale development. However, at the end of the 1970s, the existing air force replacement schedules and equipment needs did not fit industry's requirements. Industry and its allies had to fight a long and bruising domestic political battle to gain their objectives.

The 1976 National Defense Program Outline (NDPO or *Teiko*) established strict force structure guidelines still in effect today. The NDPO provided for a total ASDF fighter force structure of about 350 fighters plus a small number of fighter reconnaissance aircraft. The NDPO laid out an organization for this force of ten dedicated air-defense squadrons equipped with about 250 fighter-interceptors and three antiship and ground-attack squadrons equipped with about 100 support fighters (see JDA, 1977, pp. 72-73). Since the early 1960s, the ASDF had equipped its interceptor squadrons with its most modern high-performance fighters and had relegated the lower-performance and older fighters to the air-to-surface support role. The ASDF had procured about 230 Lockheed F-104Js beginning in the early 1960s to form seven fighter-interceptor squadrons. The F-104s were intended to replace some of the older F-86D/Fs as the premier ASDF fighter. The air force retired some of its F-86s and used the remaining aircraft as support fighters and lower-capability air-defense fighters. The McDonnell-Douglas F-4EJs began entering the ASDF inventory in 1981 to replace the remaining F-86s and the oldest F-104s in the air-superiority role. The original plan envisioned five new interceptor squadrons with F-4s and five with the older F-104s. The indigenous F-1 support fighter, approved in 1972, would begin replacing the F-86s in the surface-attack role in the late 1970s. JDA and the ASDF planned to select a replacement for the remaining five squadrons of F-104 interceptors in the mid-1970s (IISS, various issues).

¹²"Fighter Output Centered at Mitsubishi" (1980).

In late 1976, JDA requested approval to acquire 123 F-15s to replace the rest of the F-104s in the early 1980s. Budgetary and political problems led to a delay in government authorization. A year later, the government finally approved purchase of the F-15 but reduced the number to 100, providing aircraft sufficient to equip only four squadrons. Fourteen additional F-4s were authorized to permit retirement of all F-104s through the formation of a sixth F-4 interceptor squadron.¹³

Thus, the fighter modernization plan for the ASDF, as it stood in 1980, envisioned a force structure for 1985 of four interceptor squadrons of F-15s, six interceptor squadrons of older F-4s, and three squadrons of F-1 support fighters.¹⁴ The ASDF and JDA (as well as the U.S. military and DoD) believed this force structure was qualitatively inadequate to deal with the growing regional Soviet threat. The major concerns were with the F-4s and, even more, with the F-1 support fighter. During the battle for procurement of the F-15 in the mid-1970s, JDA had argued vigorously that the F-4 did not possess the capabilities necessary to counter a new generation of Soviet fighters expected to appear in large numbers by the late 1980s (JDA, 1977, pp. 85–88). However, the government had limited procurement of the F-15 to four squadrons, leaving six squadrons of F-4s to soldier on indefinitely. While the F-1 support fighter had only just started entering the inventory in 1977, it was already widely viewed as incapable of dealing with the threat anticipated at the end of the 1980s. Reportedly, ASDF pilots referred to the F-1 disparagingly as only a trainer aircraft—but for industry, not for the air force. ASDF sought early retirement of the F-1 and replacement with a more capable fighter. Thus, at the beginning of the 1980s, ASDF, the JDA, and their American colleagues continued pressing hard for new programs that would permit withdrawal of the remaining F-4s and the F-1s to begin by the late 1980s or early 1990s at the latest.

The growing American pressure on Japan for greater burden-sharing and more defense spending in the early years of the Reagan administration, combined with the perceived inadequacies in the ASDF fighter force structure because of the F-1s and the remaining F-4s, provided a golden opportunity for MHI to press the

¹³“Japanese Air Self Defense Force” (1986).

¹⁴“Japan Increasing Defense Spending Despite Decline” (1981).

government for support of its own FX fighter. Of critical importance was the apparent need to introduce replacement programs for both the remaining F-4s and F-1s at about the same time. This situation provided two advantages to industry. First, it permitted a substantial production run of nearly 200 aircraft if both types were to be replaced by a single Japanese fighter. With such a production run, industry could anticipate a lower unit cost and thus better justify an indigenous program to the government. If industry aimed at only replacing the F-1, the requirement would likely be well below 100 aircraft, thus making unit costs for an indigenous aircraft prohibitively high compared to an imported aircraft.¹⁵ Second, replacement of the F-4 provided Japanese industry with justification for developing a high-performance fighter rather than just a lower-capability support fighter to replace the F-1. The primary mission of the F-4, along with the new F-15s, was air defense against the most advanced Soviet fighters and bombers. The acceptance of additional mission responsibilities to include defense of Japanese sea lanes out to 1,000 miles raised the performance demands on Japanese fighters even more. The replacement for the remaining F-4s needed to be a world-class fighter-interceptor. The MHI design study for the FX fighter launched in the late 1970s clearly aimed at developing such a fighter.¹⁶

The fundamental difficulty with this situation from the perspective of industry was that ASDF's desired schedule for replacing the F-1 and F-4 did not permit adequate time to develop a competitive high-performance indigenous candidate. ASDF hoped to begin replacing both aircraft by the late 1980s. Industry calculated it needed at least an additional four or five years beyond that to develop a viable candidate. Ideally, industry hoped to push F-4

¹⁵An indigenous aircraft could necessitate amortization of all R&D costs over a small number of aircraft. Further, a small production run does not permit cost savings in production that take place in long production runs as workers go down the learning curve. The unit costs of U.S. aircraft reflect smaller relative R&D charges because of the much larger production runs. ASDF procured less than 80 F-1s, a tiny production run by global standards. However, amortization of the basic airframe development could be shared with the production run of the T-2 trainer, which amounted to nearly 100 aircraft, since both aircraft used basically the same airframe and engine. Thus, replacement of both the F-4 and F-1 could provide Japanese industry with about the same number of production aircraft orders as the F-1 plus T-2.

¹⁶"Fighter Output Centered at Mitsubishi" (1980).

replacement out further than F-1 replacement to permit more gradual development of high-end versions of an indigenous fighter to replace the F-4 after the F-1. Procurement of additional F-15s was an obvious solution but dangerous from industry's perspective. If the government accepted a plan to replace substantially more F-4s with F-15s, ASDF would have less need for a new high-end fighter by the mid-1990s.

Fortunately for industry, the budgetary and domestic political situation in the early 1980s was not conducive to supporting a major new authorization of F-15s. Industry, in conjunction with JDA and ASDF, instead worked out a solution to the F-4 problem that entailed procuring additional F-15s as a partial replacement and a major life-extension and system upgrade program for the F-4 that would permit it to continue on in the inventory at least through the end of the century, thus serving as a "placeholder" for the future Japanese fighter. However, this strategy required years of lobbying and intragovernmental negotiation to implement.

In 1980, the ASDF began formal analysis of possible replacements for the remaining six F-4 squadrons after 1985. For the short term, the air force clearly hoped to increase the number of authorized F-15s beyond the approved number of 100. But the MOF had already strongly opposed the current authorization requests for F-15s and P-3 Orions. Consequently, the ASDF supported industry-sponsored studies examining possible structural reinforcement and reequipping of the F-4 with a new radar and other advanced avionics. A team of specialists traveled to the United States to discuss such a program with American industry in 1981. Despite continuing pressure from the United States to increase defense spending, however, the domestic political situation and persistent opposition from the MOF prevented funding of either of these options.¹⁷

A sweeping victory in the Diet elections later in 1980 by the ruling Liberal Democratic Party permitted the government to reassess the current Mid-Term Defense Plan covering 1980–1984. In July 1982, the government approved a new five-year plan (1983–1987) that contained substantial increases in defense spending. The new plan, however, represented only a partial victory for the industry strategy regarding the F-4 replacement decision. MHI re-

¹⁷"Japan Resists U.S. Push to Boost Defense Funds" (1980).

ceived a contract to develop a Service Life Extension Program (SLEP) for the F-4. The contract covered a four-year R&D and test program during which MHI would extensively modify two F-4s as SLEP prototypes and flight-test them for two years. Structural reinforcement and installation of an all-new radar (the Westinghouse APG-66J) and other avionics would extend the useful service life of the newly designated F-4E*Jkai* into the next century. But a formal commitment to production was expected to be made only after an evaluation of the prototypes in 1985 or 1986. The total number of F-15s planned for procurement also remained unclear.¹⁸

The replacement schedule for the F-1 established in the 1983-1987 plan posed an even more serious problem for industry. The program for a new support fighter, designated the FS-X, envisioned the government placing orders for the first 24 aircraft in 1986, ASDF acceptance of the first aircraft in 1990, and initial operational capability for the first squadron in the early 1990s. This schedule implied procuring a foreign fighter or an upgraded F-1, because it did not allow sufficient time for industry to develop an all-new fighter. The ASDF had already mentioned possible foreign candidates, such as the British Aerospace Harrier and the Anglo-German-Italian Tornado, both dedicated attack fighters. The leading candidates, however, were clearly the GD F-16 and the McDonnell Douglas F-18. The F-16 had the particular advantage of being a relatively inexpensive and highly capable multirole fighter. Following the decision in 1982 to station a squadron of U.S. Air Force F-16s at Misawa air base in Honshu, selection of the F-16 by the ASDF would provide the further benefit of full equipment interoperability with U.S. Air Force units deployed in Japan.¹⁹

Another possibility that concerned industry was a decision to increase F-15 procurement and use the F-4E*Jkai* to replace the F-1s. Industry countered with a proposal for a low-cost life-extension program for the F-1 and lobbied hard for approval of its indigenous fighter. Industry's immediate objectives were to extend the F-1 replacement schedule, limit F-15 procurement, and clearly designate the F-4E*Jkai* as a placeholder for an indigenous fighter.

¹⁸Jackson (1985a); "Japanese Defense Budget Extends Growth Despite Strong Opposition" (1985).

¹⁹"F-16s to Japan" (1982); "Japan Reviews 1990s Fighter" (1983).

The domestic intragovernmental debate over indigenous fighter development soon formed along familiar lines. MOFA expressed concerns about increased friction with the United States, and MOF worried about costs. MITI generally supported indigenous development, although its Trade Bureau was also apprehensive about trade disputes with the United States. An important difference from earlier debates over indigenous development was the growing influence of the JDA Equipment Bureau, TRDI, and the ASDF planning staff. These offices had become increasingly influential in government procurement deliberations by the early 1980s, while the influence of such traditional opponents as MOF declined. Furthermore, the uniformed services in general, and the ASDF in particular, had become much stronger advocates of indigenous development. ASDF officers perceived mounting logistics, cost, and quality problems with U.S.-supplied equipment. The view was becoming widespread in the JDA and ASDF that unique Japanese operational requirements necessitated procuring a Japanese-designed Rising Sun (*hi-no-maru*) fighter. The stiffening of U.S. resistance to the transfer of defense technology on the F-15 licensed-production program and the Japanese failure to gain increased access to U.S. technology through the S&TF reinforced this trend (M. Green, 1990, pp. 40-44; Samuels and Whipple, 1989, pp. 294-296).

Advocates of an indigenous fighter finally broke the logjam in 1984 when the government agreed to implement most elements of the industry's long-term strategy. By midyear, reports began filtering out of Tokyo that consensus had been reached on a national fighter program to replace the F-1 and F-4.²⁰ A key development came in December when TRDI reported the results of a JDA and industry study on a life-extension program for the F-1. The study concluded that a modest low-cost SLEP program could delay the need to replace the F-1 by four years, to the mid-1990s. The same month, the government dropped the existing plan to order the initial buy of the FS-X in 1987. Also in 1984, the government raised the authorized buy of F-15s to 155, providing enough of the American fighters to reequip six F-4 squadrons. This furnished industry with sufficient work to keep the production lines running through the mid-1990s, at which time production could be switched over to

²⁰"Japan Plans Own Fighter" (1984).

the indigenous fighter. It also left four interceptor squadrons and over 100 F-4s as placeholders to be replaced beginning in the late 1990s by the future indigenous fighter. On July 7, 1984, MHI's F-4E*Jkai* prototype successfully made its maiden flight. After considerable flight testing, the aircraft was delivered in December to TRDI for further evaluation. Although no official decision on procurement was expected for at least a year, every indication suggested the F-4E*Jkai* program would continue into production.²¹

In January 1985, TRDI, at the request of the ASDF, commenced a formal study of the indigenous fighter option and industry's capability to develop an appropriate candidate. To no one's surprise, TRDI reported back to ASDF in April that Japanese industry was fully capable of developing an all-Japanese fighter, with the exception of the engine, that would meet air force requirements.²² A final government decision was expected at the end of the year to provide funding in the 1986 budget for the commencement of detailed design work in 1987. Given the extension in the F-1 replacement schedule, the apparent success of the F-4E*Jkai* program, and the limitation of the F-15 buy to six squadrons, few observers doubted that the indigenous FS-X would receive the official go-ahead at the end of the year. Clearly, by mid-1985, JDA and the ASDF were planning with confidence on a final force structure after 2000 of six F-15 squadrons and seven indigenous FS-X squadrons to replace the three F-1 and the remaining four F-4E*Jkai* squadrons. JDA and industry even began talking about eventually replacing the oldest F-15s with advanced versions of the national fighter, providing an ultimate production run of over 250 aircraft and setting the stage for an all-Japanese fighter force after 2000 (Jacobs, 1985).

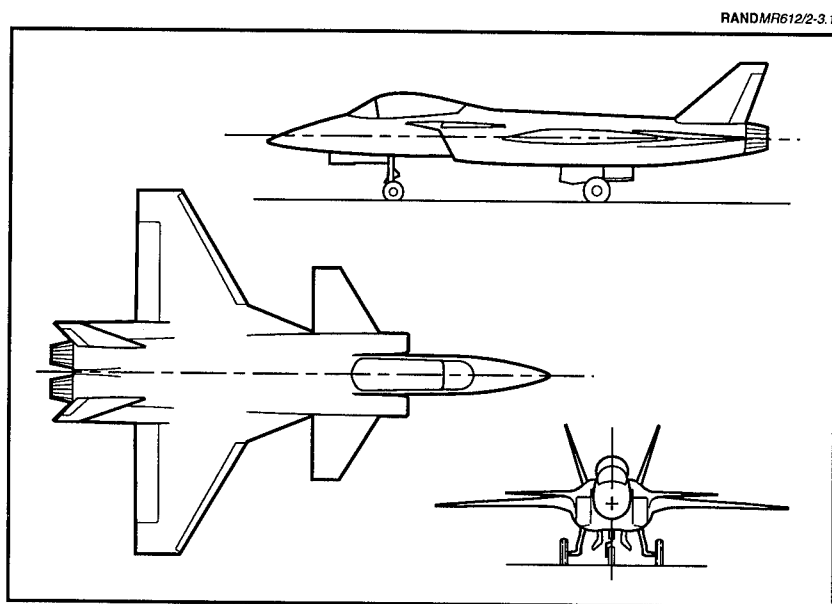
During 1985, MHI began proudly revealing more and more details of its indigenous fighter proposal based on years of design studies and wind-tunnel tests. As discussed in aerospace industry journals at the time, MHI's design objectives appeared ambitious indeed. As early as 1980, MHI had disclosed its intentions to incorporate "new aerodynamic control features" and an "integrated

²¹Ebata (1986); Jackson (1985a); "Japanese Defense Budget Extends Growth Despite Strong Opposition" (1985).

²²Ebata (1986) p. 215; "Japanese Propose FS-X Domestic Development" (1985).

flight and weapons control system" into its new fighter.²³ By 1983, the Western aerospace press had learned that the MHI design called for a delta-wing and canard configuration embodying relaxed stability for enhanced maneuverability.²⁴

Considerably more detail came out in the first half of 1985, as Japanese industry became confident that the program would definitely proceed. Their Rising Sun fighter would be a twin-engine single-seat aircraft with a shoulder-mounted double-delta main wing, horizontal canards on the nose, and canted twin vertical stabilizers. Figure 3.1 shows one design concept under study at the time. The fighter was intended to be roughly in the same class as



SOURCE: Material in Aoki (1993).

Figure 3.1—Proposed Indigenous Fighter Design

²³"Fighter Output Centered at Mitsubishi" (1980).

²⁴"New FS-X Design from Mitsubishi" (1983).

the McDonnell-Douglas F-18, the most recently deployed U.S. fighter. However, MHI engineers claimed that the Japanese FX would be 10 percent lighter than the F-18 because advanced materials would be used extensively and that it would benefit from a much higher thrust-to-weight ratio. The fighter aimed at over double the operational combat radius and twice the payload of the F-1. In the surface attack role as a replacement for the F-1, it would carry four Japanese-developed antiship missiles and two air-to-air missiles for self protection. In the interceptor role as a replacement for the F-4E*Jkai*, the fighter would carry eight air-to-air missiles and a 20-mm gun.²⁵

More surprising to outside observers was the advanced technology that MHI claimed it would incorporate into the new fighter. To attain maximum maneuverability, the Japanese fighter would employ control configured vehicle (CCV) technology utilizing an advanced triplex digital fly-by-wire (FBW) flight-control system to control the inherently unstable aircraft configuration. MHI intended to make extensive use of nonmetallic composite materials, including the development of all-composite primary load-bearing structures, to reduce weight and simplify manufacture. Finally, the Japanese design called for applying low-observable (stealth) technologies and for developing a new-generation radar and other advanced avionics (Aoki, 1993).

In 1985, Japanese industry and its allies in the government finally appeared to be on the verge of achieving their long-sought dream of commencing indigenous development of a world-class fighter. A critical component of this apparent political success had been industry's ability to demonstrate to the satisfaction of the government that it possessed the requisite technological competence to undertake such a demanding task. Development of the necessary military technological expertise had apparently been achieved with surprisingly little government spending on military R&D and had attracted relatively little attention from the U.S. government or industry prior to 1985. How did Japan succeed at this daunting task?

²⁵"SF-X Waits for Japanese Fighter" (1985); "Japanese Defense Budget Extends Growth Despite Opposition" (1985); "Japanese Propose FS-X Domestic Development" (1985).

**BUILDING THE FIGHTER
TECHNOLOGY BASE**

INTRODUCTION

Achieving the announced technological goals for the new Japanese fighter required substantial capabilities and experience in aerodynamics, design, subsystem development, materials, system integration, and a host of other areas. Yet Japan did not have a history of the large-scale dedicated military R&D funding that seemed to be required to develop such a fighter. Japan had built up impressive technological capabilities in the commercial sector but these could not always be applied easily and cheaply to military systems. Japanese commercial technology often had clear military applications on the level of parts and components. On the system level, however, most observers believed the gap was widening between the military and commercial sectors. For system development, there was no substitute for large-scale dedicated military R&D.

The conventional wisdom, confirmed by the DSB Task Force study and the DoD TATs in the early 1980s, suggested that Japanese military R&D was severely underfunded and generally far behind technology developments in the commercial sector. Although Japanese military R&D expenditures expanded rapidly in the late 1970s and early 1980s, their overall level remained relatively low. Between 1976 and 1990, military R&D grew on average by nearly 15 percent per year. But by the end of this period, these expenditures stood at a total of well under \$1 billion, compared to \$36.5 billion in U.S. military R&D outlays. At this time, total Japanese defense expenditures had grown to a level roughly equiv-

alent to that of the United Kingdom, France, or West Germany (Alexander, 1993, pp. 5–6).¹ Although it is widely believed that official Japanese figures for military R&D significantly understate the true level of spending, it is still unlikely to be more than that spent by such countries as the United Kingdom and Germany (Chinworth, 1989a). Yet these two countries had long since given up the prospect of developing a first-line fighter on a national basis. The high cost of modern fighter development had driven them to pool their military R&D funds with Italy and Spain in the mid-1980s to provide the \$12 billion over ten years thought necessary to develop the future European Fighter Aircraft (EFA). The Japanese just did not seem to have a history of military R&D spending to support that scale of outlays.

One American expert recently noted that the apparent Japanese decision to develop the FS-X indigenously showed “a great deal of hubris over their ability to transform technology, much of it civilian, into an advanced attack aircraft.” (Alexander, 1993, p. 39.) Indeed, Japanese industry had chosen to take on a task of staggering complexity normally contemplated only by industries with decades of experience in fighter development. By the mid-1980s, France, with its Rafale A fighter demonstrator, remained the only country in the world other than the United States and the Soviet Union still attempting truly indigenous development of a first-line fighter. Britain, Germany, and Italy were struggling to launch a collaborative R&D program for the EFA after France effectively dropped out of the joint effort in the summer of 1985. Sweden and Israel had active fighter programs under way for developing the Gripen and Lavi, respectively, but they were so dependent on U.S. subcontractors and technology that, in some respects, these amounted to informal collaborative programs with the United States.² Taiwan had hired General Dynamics in the early

¹Alexander uses an exchange rate of ¥202 rather than ¥143 to the dollar based on an assessment of actual purchasing power parity value. Even using the conventional exchange rate, Japanese military R&D expenditures remain well below \$1 billion.

²The Lavi program was largely financed by the United States, which forced cancellation of the program in late 1987. Both the Gripen and Lavi depended on U.S. engines and many other major subsystems and technologies. Sweden subcontracted development of the Gripen wing to British Aerospace, while Israel hired Grumman to develop the Lavi wing. Lear-Siegler in California developed the flight-control system software for both fighters. See Lorell (1989).

1980s to help it develop a basic fighter equipped with U.S. subsystems. Similarly, India was trying to get assistance from the French and Americans to support their Light Combat Aircraft proposal. China was undertaking several development programs that relied on foreign technology and that never resulted in production aircraft.

By the 1980s, even the European countries with long histories of military aerospace R&D were beginning to fall further behind the United States in key technologies and new-generation subsystem development, particularly in fire-control radars and other avionics. The European partners on EFA were seriously considering modifying the American radar already installed in the F-18 (the Hughes APG-65) for their future fighter. Later, they chose to develop their own radar collaboratively, but it would be based on conventional technology a generation behind the APA radar under development by the United States for the ATF program. With decades of experience in military radar R&D, the French hoped to develop a relatively advanced passive phased-array radar for the Rafale, but it was expected to fall far short of cutting-edge developments in the United States. Yet, Japanese industry, which had never indigenously developed any fighter fire-control radar, seemed determined to develop an indigenous system for its new fighter.

In the 1970s and 1980s, the Japanese adopted a unique long-term incremental strategy to build up at least the basic level of experience and technological know-how necessary to make them competitive in the fighter development business. This strategy remained relatively low cost and largely hidden from public view, at least prior to the full-scale development of the FS-X. For these reasons and others, Western aerospace experts and Pentagon officials generally remained highly skeptical about Japan's ability to develop a world-class national fighter. They failed to recognize the effectiveness and efficiency of the Japanese approach.

The Japanese strategy sought first to maximize the benefits to the domestic defense industrial base derived from licensed production of the F-15 and other licensed-production programs. Second, it called for utilizing other, related military programs to gain the skills necessary for the demanding task of fighter subsystem development and integration. Third, the strategy required TRDI to focus its growing but relatively limited funds on high-leverage military research programs that would directly contribute to enhancing

capabilities necessary to develop an advanced fighter and that could not be acquired from licensed-production programs or from the commercial sector. Finally, Japanese industry, particularly the electronics sector, effectively mined the enormous expertise it had developed in civilian markets to spin on sophisticated commercial technologies and manufacturing techniques to key military subsystem applications. This strategy did not transform Japan overnight into a world leader in military aerospace technology. But it did provide Japanese industry with the capabilities, at relatively low cost and low risk, to argue credibly for the development of an indigenous fighter.³

LEARNING FROM LICENSED PRODUCTION

The Unique Nature of the F-15 Program

Licensed production of the F-15 actually contributed little to increasing Japan's capabilities in the commercial aerospace sector as so feared by some members of Congress, but it did help lay the foundations for the military industrial base necessary to develop and produce the Japanese indigenous fighter.⁴ Although it condemned Japanese industry to manufacturing another generation of U.S. fighters, the F-15 deal also in certain respects represented an impressive coup for Japanese industry. The F-104, which Japan had license-produced in the 1960s, never gained widespread acceptance in the U.S. Air Force and was only procured by the American military in small numbers.⁵ The F-4E served as the backbone of the U.S. Air Force tactical fighter force in the 1960s and 1970s, but Japanese industry continued to produce this fighter well after production had ceased in the United States. In the case of the F-15, however, this expensive and highly capable fighter was just entering service in the U.S. Air Force as America's premier air superior-

³Richard Samuels and Benjamin Whipple (1989, pp. 293-301) lay out much of the basic thesis presented here.

⁴The extensive transfer of critical fighter technologies to Japan on the F-15 program is documented in Chinworth (1989a), pp. 96-131. Chinworth makes a similar argument in the case of the Japanese licensed production of the U.S. Patriot missile system (Chinworth, 1989b, p. 33).

⁵The bulk of F-104 production was carried out in Europe under license by a consortium led by West German firms.

ity fighter when Japan signed the agreement for licensed production.⁶ The leading representative of a whole new generation of fighter aircraft, the F-15 used cutting-edge military technology in its airframe and systems, especially in the all-new Pratt & Whitney F-100 turbofan engine and the Hughes APG-63 pulsed-Doppler fire-control radar and other avionics. In addition, the F-15 was one of the world's first fighters to use carbon fiber and other composite materials extensively in its structure.⁷

No other country in the world has ever been granted the right to license-produce the F-15. Only two other countries—Israel and Saudi Arabia—have been permitted even to purchase the aircraft off the shelf from the United States. Part of the explanation is that few other countries could afford to purchase or license-produce such a high-performance fighter. Those that could preferred national or collaborative development of their own fighters. But there may have been another factor involved in the case of Japan. According to one knowledgeable source, a key element in Japan's decision to approve development of the FST-2/F-1 fighter in 1972 was DoD's refusal to permit licensed production of the F-5E in hopes of forcing Japan to purchase the U.S. aircraft off the shelf (Samuels and Whipple, 1989, p. 294). DoD may have learned its lesson from this earlier episode. Licensed production of America's most advanced fighter may have been viewed by the Pentagon as the necessary price to be paid for discouraging Japan from turning again to indigenous development. In addition, prior to the F-15 agreement, Japan was also assessing other foreign alternatives, such as the French Mirage F.1, the Swedish Viggen, and the Anglo-German-Italian Tornado. Pentagon officials argued that Japan would have been much more likely to select licensed production of one of these less-capable aircraft than buy the F-15 off the shelf if they had been denied the opportunity to manufacture the F-15 domestically (GAO, 1982, p. 7).

Japanese industry stood to gain considerable insight into state-of-the-art U.S. military technologies through licensed production of the F-15. However, by the late 1970s, the Pentagon was already

⁶The first USAF F-15 squadron achieved initial operational capability in January 1976. Japan selected the F-15 less than 12 months later.

⁷A detailed technical description and program history of the F-15 can be found in Gething (1983).

coming under strong congressional criticism for transferring too much technology to Japan in licensed-production programs. In response to this criticism, DoD sought to reduce significantly the technology transferred in the F-15 program compared to earlier licensed-production efforts by prohibiting Japanese participation in manufacturing key components and subsystems. As a result, the United States "black-boxed" many sensitive components for the F-15 (i.e., supplied the components only as end-items from U.S. contractors for insertion by the Japanese into their aircraft). DoD denied access to certain software, the entire electronic warfare (EW) system, and the "hot" core section of the F-100 engine.⁸ Although precise data are unavailable or unreliable, most observers agree that direct Japanese participation in the manufacture of the F-15 was less than in earlier programs, particularly the F-4.

Japanese industry, the JDA Equipment Bureau, and the ASDF criticized these restrictions bitterly. Industry, of course, resented the U.S. denials of access to important new technologies that could help in developing a Japanese fighter. ASDF officers argued that the restrictions complicated logistics and maintenance by making Japan dependent on a long and slow logistics pipeline to the United States and prevented necessary modifications of software and subsystems. These problems helped solidify growing support in the ASDF for industry's efforts to develop an indigenous fighter.

Japanese dissatisfaction with the F-15 agreement also contributed significantly to the initial failure of the U.S.-Japan S&TF in 1980. The Japanese participants viewed the S&TF primarily as a means of loosening the restrictions imposed on technology transfer in the F-15 MoU. The Japanese used the S&TF to request greater access to the F-100 engine, the flight-control system, the AIM-9 air-to-air missile, and composite materials. Most of these requests were denied. Industry soon lost interest in the S&TF once it became clear that it would not serve as an effective avenue for acquiring more F-15 technology (M. Green, 1990, pp. 40-41).

⁸DoD did not single out Japan for imposition of these types of restrictions. For example, in the early 1970s, the French firm SNECMA had been denied access to the hot-section engine technology in a collaborative program with General Electric for the development of the CFM-56 turbofan. In another example, the Pentagon prohibited access to sensitive software and other technologies by four European participants in the coproduction of the F-16 in the late 1970s.

Japanese industry, however, achieved greater success elsewhere in this endeavor. After initiation of the F-15 program, JDA and other government officials held annual meetings with Pentagon officials to review the release of U.S. technology. At these meetings, the Japanese routinely requested increased access to F-15 technology and often received favorable answers. As a result, Japanese industry eventually acquired advanced composite material processing and bonding technology, as well as other technologies that had been prohibited in the initial MoU. To assist in transferring complex manufacturing processes, McDonnell-Douglas trained numerous Japanese technicians at its St. Louis plant. At the height of the program, the U.S. contractor stationed 40 technical experts at Japanese companies to provide support for the licensed-production program (GAO, 1982, pp. 7, 14).

Military Versus Commercial Spin-Offs from the F-15

There is little doubt that participation in the F-15 licensed-production program afforded Japanese companies considerable insight into the design and manufacture of a high-performance fighter. A recent GAO report suggests that the know-how acquired by Japanese firms had little applicability to commercial aircraft but substantially increased Japanese capabilities for military aerospace programs. The GAO study, commissioned by Congress in 1991, had explicitly set out to demonstrate that involvement by Japanese firms in the licensed production of the F-15 provided those firms with the necessary capabilities to compete successfully against U.S. companies for major subcontracts on commercial transport programs conducted by Boeing and Douglas Aircraft. But the study failed to prove its case (GAO, 1992b).

The GAO analysts carefully assessed the activities of 40 major Japanese aerospace contractors on the F-15 program to determine what participation they had on U.S. commercial programs. To their surprise, they discovered that the correlation was not very strong. Of the 40 Japanese F-15 companies examined, only 18 had any involvement in Boeing or Douglas airliner programs. Of these, only ten—or 25 percent of the total firms reviewed—provided closely related parts or components to both military and civil programs. For example, MELCO, one of Japan's top five defense contractors, license-produces the Hughes APG-63 fire-control radar,

the IBM central computer, the radio, actuators, and numerous other items on the F-15. MELCO also participates in Boeing commercial programs but supplies only minor items, such as actuators, shutoff valves, and electric chimes. Not surprisingly, the GAO (1992b, pp. 3, 19) was forced to conclude that

no single, causal relationship exists between Japanese companies' participation in the F-15 coproduction program and their involvement in the production and development of Boeing and Douglas civil airplanes.

However, the GAO investigators did discover that the F-15 and other U.S. military licensed-production programs appear to have substantially increased the capabilities of Japanese contractors to provide critical parts and components for an indigenous fighter. Drawing on the results of an earlier U.S. Air Force study, the GAO noted that nearly all the companies competing to provide parts and subsystems for an indigenous fighter cite the experience and know-how gained from producing similar U.S. items under license during the F-15 program or earlier licensed-production programs. Thus, it was in the area of military technology that the GAO identified "a more direct link" between military licensed-production programs and enhanced indigenous capabilities. In short, contrary to the assertions of the 1982 GAO report, licensed production of the F-15 did not so much build up Japan's commercial aerospace capabilities as it did its military aerospace capabilities (GAO, 1992b, p. 10).

Nonetheless, Japanese industry and the JDA fully recognized the limitations of technology transfer in licensed-production programs with the United States. Although these programs can provide considerable insight into the final U.S. design solutions, they primarily involve the transfer of manufacturing and process technology and management know-how.⁹ Even here, studies have shown that the transfer of wholly new technologies and processes is difficult in licensed-production programs (see Hall and Johnson, 1968). Licensed production provides no experience with, and little insight into, the incredibly complex process of designing, develop-

⁹See the comments on the 1982 GAO report provided by the Bureau of Industrial Economics, DoC, in GAO (1982), Appendix III, p. 44.

ing, and integrating a modern fighter and its major subsystems. The exacting design process, which often depends on complex design trade-off methodologies developed through years of trial and error, remains hidden. Furthermore, licensed-production programs embody technology and designs developed years earlier during the R&D phase of the program, in which the licensee does not take part.

In any event, the increasing U.S. tendency to black-box technology in licensed production, as on the F-15 program, meant that even less benefit could be derived from these programs. The experience the Japanese gained developing the T-2 and F-1 had been critically important for filling in some of these gaps. But the F-1 had been a relatively simple fighter based on a derivative design and had used mostly foreign subsystems. The F-15 is a far more advanced and capable fighter. And as Japan commenced licensed production of the F-15, other countries were already in the early stages of developing even more advanced fighters. To develop a competitive indigenous fighter, Japanese industry needed to conduct a considerable amount of additional preliminary R&D dedicated to its own indigenous fighter development.

GAINING EXPERIENCE IN SYSTEM INTEGRATION

Foreign observers commonly argue that, because of its dependence on licensed production, Japanese industry failed to develop experience in the critical area of system integration of major aerospace platforms and subsystems. This has often been viewed as one of the most critical shortcomings of the Japanese aerospace industry (Samuels and Whipple, 1989, pp. 298-299; Alexander, 1993, pp. 41-42). Effective system integration requires a myriad of organizational, design, and engineering skills to manage the coordination of a vast array of subsystems and technologies into a single airframe to produce an operationally useful fighter weapon system. System integration for fighters is probably far more complex and demanding than virtually any analogous effort in the commercial arena. The necessary know-how can only be acquired through direct experience.

Japanese industry was well aware of its lack of experience in this area. In the late 1970s, it set out to remedy this shortcoming. Lacking the large-scale programs and huge financial resources

available to the American defense industry, it adopted a relatively low-cost incremental strategy designed to help it acquire the system integration experience necessary for attempting fighter development (see Samuels and Whipple, 1989, pp. 286–287, 299–301).

Integration of advanced avionics—especially with new computer-operated electronic flight-control systems, integrated EW systems, and new-generation radars and weapon management systems—posed among the greatest challenges for developers of fighters in the 1980s (and still does today). At this time, avionics development and integration were already accounting for nearly half the cost of fighter R&D. Japanese industry sought to increase its experience in avionics development and integration in three major procurement programs launched in the early 1980s: the F-4E*Jkai* fighter, the XSH-6J helicopter, and the T-4 jet trainer.

The F-4E*Jkai* Fighter

The F-4E*Jkai* program, already discussed in Chapter Three, was critical for extending the service life of the ASDF F-4s to act as placeholders for the indigenous FS-X. In this program, Japanese industry took a basic reinforced F-4 airframe and incorporated 47 new items. These items included all the major avionics subsystems, such as the F-16A fire-control radar, the F-15 central computer, head-up display (HUD), INS, and a Japanese EW system.¹⁰ Since most of these items were proven systems of American design, Japanese industry could focus entirely on learning the complexities of integrating advanced avionics systems combined in a completely new way, a task denied them on the F-15 licensed-production program.

The XSH-60J Helicopter

In the next program, the XSH-60J R&D effort, Japanese industry advanced a notch beyond the F-4E*Jkai* to develop and integrate indigenous avionics into the new but less demanding environment of a helicopter airframe. Originally, the 1983–1987 defense procurement plan had projected licensed production of 60 Sikorsky

¹⁰“Japan” (1985), pp. 74–76.

SH-60 antisubmarine warfare helicopters for the MSDF. In 1984, Japanese industry convinced the government to alter the program radically into an indigenous avionics development and integration exercise. Instead of license-producing the American helicopter, TRDI would purchase two unequipped airframes that would then be fitted out with all-Japanese avionics. The leading national avionics house, Japan Aviation Electronics Industries (JAEI), would develop an automatic flight management system and the world's first attitude and heading reference system applied to an antisubmarine warfare helicopter, which used a ring-laser gyro. JAEI intended to build on the experience it gained license-producing the advanced gyro and automatic flight-control system for the F-15. Other high-technology military electronics systems to be developed by Japanese industry for the XSH-60J included computerized sonar buoys and an onboard computerized sound processing system. The government designated MHI as the prime contractor for system integration. MHI planned to complete development and begin flight testing in 1988, just as full-scale development of its indigenous FS-X was planned to begin.¹¹

The T-4 Jet Trainer

The third effort, the MT-X (later XT-4) trainer program, offered industry an opportunity for additional experience with subsystem development and integration. Even more important, this program served as a full dress rehearsal for developing an indigenous fighter. Launched in 1981 after TRDI selected a Kawasaki design proposal over a competing submission from Fuji, the program called for developing a relatively low-performance subsonic intermediate trainer to replace the aging Fuji T-1 and Lockheed/Kawasaki T-33 trainers in the ASDF inventory. With the XT-4, Japanese industry carried out the development and integration of its first all-national military jet aircraft since the Fuji T-1 program began in the late 1950s. Except for three items—the ejection seat, HUD, and onboard oxygen system—all subsystems and components would be developed by Japanese companies, including the engine. IHI, which had license-produced

¹¹Jackson (1985b); "Japanese Defense Budget Extends Growth Despite Strong Opposition" (1985).

many American fighter engines, developed the small XF-3-30 turbofan to power the XT-4 in collaboration with TRDI. Kawasaki Heavy Industries (KHI), working together with MHI and Fuji Heavy Industries (FHI), used advanced computer-assisted design and manufacturing techniques for the first time in the XT-4 program. JAEI developed several avionics subsystems for the program, including an attitude and heading reference system incorporating a laser gyro.¹²

By all accounts, the XT-4 R&D program proved highly successful. Unlike many American and other foreign military aircraft programs, it progressed on schedule and within its original budget. The first of four prototypes flew in July 1985. According to the contractors, flight testing demonstrated that the XT-4 met or exceeded all performance requirements. Japanese industry gained substantial experience and confidence with the XT-4 program in managing the development and integration of an indigenous military jet. The program provided an opportunity to design, develop, and integrate major military subsystems, such as the engine and avionics. Its success bolstered industry's arguments that Japan was now ready to proceed with a national fighter development program.

TARGETING DEVELOPMENT OF KEY TECHNOLOGIES FOR THE FUTURE FIGHTER

While the F-4E*Jkai*, XSH-60J, and XT-4 programs furnished industry with the opportunity to advance its skills in system development and integration, these programs did not address other key areas of technology and subsystem R&D necessary for the future Japanese fighter. TRDI's integrated technology strategy met this challenge by supporting a variety of dedicated military technology demonstration and development programs. Table 4.1 lists some of the most important research programs for fighter aircraft development TRDI conducted in the 1980s. The remainder of this section examines in greater detail TRDI's efforts in the areas of advanced aerodynamic research, development of FBW and CCV

¹²"Japan's National Policies Clash with Cooperative Efforts Abroad" (1985).

Table 4.1
Major TRDI Fighter Technology R&D Programs

Research Area	Funding (billion ¥)	Time Frame (FY)
Fighter design	0.3	1973-1987
Composite materials	1.7	1974-1987
T-2 CCV program	6.1	1978-1985
Fire-control radar	4.4	1981-1987
Mission computer	2.4	1983-1988
EW system	1.7	1985-1989
Inertial navigation	1.0	1985-1988
Stealth	0.3	1986-1989

SOURCE: Based on material in Hata (1993).

NOTE: Program costs in this table are apparently accumulations of "then-year" funding allocations by TRDI. Therefore, they have not been adjusted for inflation.

technologies, advanced composite materials and structures, and APA fire-control radars.¹³

Advanced Flight-Control Technology

One of the most demanding technology areas for future fighters in the 1970s and 1980s was the development of computer-operated FBW flight-control systems that permitted active control of "relaxed stability" aerodynamic designs for much higher maneuverability.¹⁴ Many observers believed this technology would permit the development of a new generation of supermaneuverable fighters that could outclass all existing fighter aircraft in future combat. The United States developed analog and digital FBW systems in experimental programs using flying technology demonstrators in the early 1970s. The General Dynamics F-16A/B, which began deployment in the early 1970s, was the first operational fighter

¹³"Japanese Near Decision on FS-X as Replacement for Mitsubishi F-1" (1986).

¹⁴Conventional aircraft are designed for stable flight when the mechanically operated flight-control surfaces are in a neutral position. FBW systems permit the design of aircraft that are aerodynamically unstable at all times. Flight-control computers programmed with complex software intervene between the pilot's control stick and numerous flight-control surfaces, permitting stable flight and enhancing maneuverability. See Tomayko (1992).

with a full-authority FBW system. Entering squadron service in the early 1980s, the McDonnell-Douglas F-18 was the first operational fighter equipped with a more advanced and capable digital FBW system. Lear-Siegler later developed a digital FBW system for the F-16C/D.

Although equipped with FBW, the F-16 and the F-18 are only marginally unstable aerodynamic designs. The U.S. Air Force sponsored the CCV YF-16 technology demonstration program in the late 1970s to explore much more radical applications of CCV technology to achieve unorthodox maneuvering capabilities. General Dynamics modified a YF-16 equipped with an analog FBW system with two vertical canards mounted on the engine air intake to provide direct side-force control. This permitted the CCV YF-16 to point its nose away from the aircraft's direction of flight, or "decouple" the aircraft's longitudinal axis from its velocity vector. The CCV YF-16 was able to execute a variety of other unusual maneuvers that could potentially enhance combat capabilities of future fighters. This program was followed in the early 1980s by the Advanced Fighter Technology Integration (AFTI) F-16 program. The new program sought to build on the successes of the CCV YF-16 by exploiting the greater capabilities provided by digital FBW computers. The program's F-16 demonstrator, also equipped with two vertical "chin" canards, investigated six different decoupled modes of flight maneuvering, including direct side force and direct lift, and their possible applications in future combat (*Jane's All the World's Aircraft*, various years).

The enormously enhanced control capabilities FBW technology provided also allowed the U.S. industry in the early 1980s to experiment with a wide variety of other novel configurations and maneuvering regimes, spawning such programs as the Rockwell Highly Maneuverable Technology (HiMAT) remotely piloted vehicle, the Grumman X-29, and the Rockwell-MBB X-31. The new FBW technology also permitted American industry to develop the first stealthy low-observable fighter, the Lockheed F-117, which required a highly unconventional aerodynamic configuration to reduce its radar cross section.

The experienced European fighter developers lagged behind the Americans in these areas but devoted considerable resources to catching up. By the early 1980s, the French Dassault Mirage 2000 commenced production with an analog FBW system, representing

the only European operational fighter with full-authority FBW technology.¹⁵ At about the same time, the French began work on their Rafale A technology demonstrator to test a digital FBW system in a more aerodynamically unstable design. British, German, and Swedish industry also undertook technology demonstration programs using heavily modified existing fighters as test beds to develop digital FBW systems and other CCV technologies for possible application to new fighters in the 1990s (Lorell, 1989, pp. 18–19, 25–26, 36–37).

Unlike their American and European counterparts, TRDI and Japanese industry had little experience with fighter technology demonstration programs. But in a major departure from the past, and little noticed by the world aerospace community, Japan launched its own research into active control technology and unstable designs for future fighters in the late 1970s. TRDI selected the Mitsubishi T-2 in 1978 as a test-bed aircraft to develop FBW capabilities and investigate CCV technologies, with MHI commencing design work in April. The Mitsubishi T-2CCV made its first flight in August 1983, about a year and a half after the maiden flight of the similar British Aerospace test bed, the ACT Jaguar demonstrator. The T-2CCV boasted a triplex digital FBW system that operated newly added control surfaces to test decoupled fight modes and other novel maneuvering regimes. These included two horizontal canards and a single vertical canard to investigate direct lift control and direct side-force control (*Jane's All the World's Aircraft*, various years).

TRDI and MHI conducted flight tests with the T-2CCV through 1986. Little is available in the public literature on the results of the flight tests. However, it is generally believed the Japanese experienced many technical difficulties during the program. Clearly, the United States, with its multiplicity of CCV technology demonstration programs and its wide array of operational and experimental military applications of FBW technology, remained far ahead of Japanese industry. However, the key point of the T-2CCV program was that, through it, Japanese industry gained enough experience and confidence to be able to credibly offer a design proposal for its indigenous FS-X that incorporated the relaxed stability

¹⁵Some observers believe the French acquired the basic technology through their links with Belgian firms involved in the licensed production of the F-16.

design and a digital FBW control system thought necessary for a competitive first-line fighter for the 1990s.

The T-2CCV represented a dedicated military technology demonstration program. In another area of great importance for future fighters, the development of composite materials and structures manufactured from carbon-fiber-reinforced plastics, TRDI and industry pursued a clever strategy of combining dedicated military R&D, considerable spin-on from the commercial sector, and exploitation of capabilities acquired in both military and commercial collaborative programs with the United States.

Composite Materials and Aircraft Structures

Along with MELCO's APA radar, the single-piece cocured composite fighter wing MHI developed would become one of the two central technological areas of contention between the United States and Japan during negotiations over the FS-X fighter in the late 1980s and early 1990s. The FS-X wing development program grew out of an impressive Japanese industry and government effort dating back to the early 1970s to develop advanced aerospace composite technologies.

Composite materials essentially combine a fibrous reinforcement in a matrix to achieve a lightweight, high-strength substitute for conventional aluminum. Today, the most common aerospace composite material is made of epoxy resins reinforced with carbon fibers, commonly known as carbon-fiber composites (CFCs). The use of fiber-reinforced plastics in aviation applications dates back at least to the 1940s. Engineers originally sought to substitute these strong lightweight materials for aluminum in aircraft structures primarily to save weight, thus increasing either payload or range. Other benefits later pursued included lowered manufacturing costs through reduced numbers of parts in composite structures and new aerodynamic designs based on aeroelastic tailoring of aircraft structures. Composites also became critically important for developing low-observable (stealth) aircraft (Bashford, 1990).

U.S. government-sponsored military research into the aerospace applications of advanced composite materials greatly accelerated in the 1960s. Initially, composites were used only in areas that were not "flight critical," such as access panels and landing-gear doors. But by the end of the decade, the Grumman F-14

fighter, with its boron-epoxy horizontal stabilizer, became the first production fighter designed with a flight-critical composite structure. The 1970s witnessed a dramatic increase in the application of composites to military aircraft, with graphite-epoxy (a CFC) replacing boron-epoxy as the dominant material. For U.S. military aircraft developed during that decade, use of composite materials as a percentage of total structural weight rose from 3 percent on the General Dynamics F-16 to 10 percent in the McDonnell-Douglas F-18 developed at the end of the decade. Major composite structures on the F-18 include the rudders, horizontal stabilizers, wing skins, and many fuselage panels. By the end of the 1970s, the use of CFCs in military aerospace had become well established and was expanding rapidly. In November 1978, the McDonnell-Douglas AV-8B Harrier prototype made its maiden flight as the first fighter equipped with a wing made entirely out of graphite-epoxy composites. Designers began contemplating future aircraft manufactured almost entirely out of CFC materials (Resetar, Rogers, and Hess, 1991, pp. 1-15).

Through the 1970s, the United States and several European countries led the world in aerospace applications of CFCs. However, Japan had already developed a strong commercial position in various aspects of composite technology by the end of the 1960s. During that decade, Japanese industry, drawing on the strength of its chemical industrial sector, conducted extensive research into graphite materials. By the end of the decade, Japan's Toray Industries had become the world's leading producer of the most widely used type of carbon fibers¹⁶ and retained this position throughout the 1970s. Japanese industry applied composite materials primarily to sporting goods. Its main finished products included fishing rods, golf clubs, and tennis rackets. The sporting goods market, however, remained relatively small and unstable. The Japanese CFC industry was eager to find new markets for its products and new applications of its technology (Channon, 1981, pp. 277-288).

Early Japanese Research on Aerospace Composites. Although Japan had become a world leader in carbon-fiber technology by the 1970s and had amassed considerable manufacturing capabilities by producing composite sporting goods, it lacked experience in designing and manufacturing large aircraft structures.

¹⁶Carbon fibers based on polyacrylonitrile (PAN) precursors.

Following the lead of American and European contractors, Japanese aerospace began moving rapidly to rectify these shortcomings through government-sponsored research programs. MHI initiated basic research into carbon-fiber epoxy materials for aerospace applications at the end of the 1960s. In the early 1970s, Mitsubishi launched studies investigating new material systems (fibers and matrix) and fabrication processes. In 1973, TRDI funded Mitsubishi's first major application research for developing a composite nose landing-gear door for the T-2. With support from Toray and Mitsubishi Rayon, MHI developed and flight-tested the composite landing-gear door, whose structure was similar to comparable composite items developed in the United States. Five years later, MHI commenced development of its first primary or flight-critical composite structures, the vertical and horizontal canards mounted on the T-2CCV technology demonstrator funded by TRDI (Channon, 1981, pp. 289-293).

These government-funded R&D programs built on and supplemented experience gained from both military and commercial collaborative production programs. Kawasaki's early experience with fiber-reinforced plastics came from manufacturing items for the F-4EJ licensed-production program. In August 1980, MHI won U.S. government permission to manufacture under license a substantial number of boron-epoxy parts on the F-15. Japanese companies were also intimately involved with the development of composite structures for the Boeing 767 airliner program, formally launched in September 1978, and for other related development projects. Japanese engineers participated in nearly every phase of the advanced composite development program for the B.767 in Seattle. Boeing personnel carefully worked with their Japanese colleagues to transfer the resulting composite manufacturing processes to Japan. This collaborative program with Boeing clearly contributed to a major expansion in composite structure manufacturing capabilities for Japanese prime contractors, especially Kawasaki and Fuji.¹⁷

In the late 1970s, Japanese industry and government also implemented a coordinated domestic program to advance aerospace composite capabilities dramatically beyond the relatively modest

¹⁷Fuji's first experience with CFCs was acquired through the B.767 program. See Channon (1981), pp. 302, 380-381, 420.

levels already achieved. A major turning point came in 1978, when MHI and the National Aerospace Laboratory (NAL) agreed to collaborate on the development of an all-composite tail plane for a Kawasaki C-1 jet transport that NAL was modifying to investigate technologies for short takeoff and landing (STOL). With a span of 36 feet, the modified C-1 tail plane represented a larger all-composite primary structure than the main wing of the AV-8B Harrier just developed by McDonnell-Douglas. The program was intended to provide MHI with experience in designing and manufacturing large complex structures. The program also furnished MHI with the opportunity to develop the cocuring process, a manufacturing approach in which composite parts are bonded together by heat during the curing stage, eliminating the need for traditional metal fasteners.¹⁸ Also in 1978, Kawasaki began developmental work on carbon-fiber structures for extensive application to the MT-X indigenous trainer program, based on earlier experience gained in developing a composite ground spoiler for the C-1 transport and fuselage panels for the BK-117 helicopter codeveloped with a German firm. At least some American technical experts believe these programs drew directly on the technology and expertise acquired by Japanese engineers during their association with Boeing on commercial aircraft development programs.¹⁹

This government-funded development work clearly had commercial applications and enhanced the leverage of Japanese companies for gaining additional development experience and foreign technology through collaborative commercial programs. In the early 1980s, Japanese companies opened negotiations with both Boeing and Airbus Industry to win a much more significant role in the design and development of a future airliner. In negotiations with Boeing, Japanese industry fought hard to win the right to develop the composite tail section of the proposed airliner, which was called the YXX or 7J7. In early 1984, the two sides signed an MoU for joint development. Japanese companies sent a team of about 50 engineers to Boeing's Seattle facilities to learn and help transfer the U.S. firm's composite technology for use on the tail section.

¹⁸"Technical Evaluation of STOL Aircraft" (1981), pp. 29-30; Channon (1981), p. 293.

¹⁹For example, see the testimony of James Burns, vice president of Hercules Inc., a leading U.S. composite materials firm, in House (1989a), p. 51.

Mitsubishi and Fuji began development of a composite horizontal stabilizer torque box for the airliner in 1985. Boeing eventually halted the 7J7 effort because of unfavorable market conditions, and the Japanese team was disbanded. Nonetheless, this effort, building on the experience gained through the C-1 composite stabilizer program, provided additional experience in primary composite structures (House, 1989a, p. 298; Mowery and Rosenberg, 1985, p. 12).²⁰

MHI Begins Development of a Cocured Composite Fighter Wing. By the early 1980s, however, MHI felt ready to take on a dramatically new technological challenge, which if successful, could catapult it into the leading ranks of aerospace contractors in the area of primary composite structures. Drawing on the accumulated experience from in-house studies, licensed-production programs, the collaborative work with Boeing, the research programs funded by TRDI and NAL, and the commercial carbon-fiber industry, Mitsubishi set out to develop an all-composite cocured integral main wing box for its proposed indigenous fighter. Launched in 1981 under TRDI auspices, the program focused on the development of structural designs and the optimal tooling and manufacturing processes (Moteff, 1989, p. 5; Channon, 1981, p. 290). Interestingly, this appears to be another case where Japanese industry was attempting to spin on commercial aerospace technology to the military sector, rather than vice versa. MHI's initial experience with a large cocured wing structure came through the effort to develop a composite tail plane for the STOL transport technology program (mentioned above), which was sponsored by NAL, and through collaboration with Boeing on commercial programs.

The decision to develop a cocured integral composite wing box for the indigenous fighter represented a high-risk strategy to leapfrog to the cutting edge of composite technology. Development of a cocured composite fighter wing was far more technically demanding than development of a horizontal stabilizer for a transport air-

²⁰More recently, Japanese companies successfully concluded a deal with Boeing for the joint development of the next-generation B.777 airliner. Again, the Japanese companies went into the negotiations hoping to get the all-composite horizontal stabilizer included in their workshare, but this time failed.

craft. In the early 1980s, worldwide experience with large load-bearing composite structures was still relatively limited. The AV-8B Harrier remained the only fighter with an all-composite wing. Fighter wings are particularly difficult structures to design and manufacture entirely out of composites, because they are large complex structures subjected to very high aerodynamic stresses. CFC pieces must be built up from layers of material "laid up" on tools or forms, then cured by being subjected to controlled heat and pressure in large chambers, or autoclaves. In the case of the AV-8B wing, McDonnell-Douglas adopted a relatively conservative approach of separately laying up and curing the individual structural pieces and skins on different tools, then assembling them in a conventional manner using metal fasteners as if they were metal parts. The Japanese cocuring approach sought to position all the structural parts of the wing, such as the spars and ribs, on the lower wing skin on a single large tool or form, after which the entire structure and all its parts would be simultaneously cured in a large autoclave. This process results in a single integral wing box structure to which the top CFC skin is then mechanically fastened. In principle, this process reduces structural weight, as well as manufacturing time and costs, by eliminating the need to drill thousands of holes and mechanically assemble the wing parts with traditional fasteners (Klein, 1988; McDonnell-Douglas, 1990).

Cocuring critical load-bearing structures was not a new idea to American or European industry in the early 1980s but was generally considered to be technologically and operationally risky, as well as very expensive because of the high cost of the specialized tooling required by the manufacturing process. American aerospace companies already used cocuring widely for smaller structural parts. U.S. research programs in the 1970s extensively investigated the manufacture of CFC wing and fuselage structures without fasteners through a process called adhesive bonding. McDonnell-Douglas actually manufactured the horizontal stabilizer of the AV-8B Harrier using a cocuring process similar to the proposed Japanese approach. Several U.S. programs in the early 1980s were continuing research into advanced all-composite wing configurations and manufacturing techniques. British, German, and Italian industry announced a program in 1982 to develop a fighterlike technology demonstrator that would incorporate cocured CFC wings. This aircraft, the Experimental Aircraft Program

demonstrator, successfully flew in 1986.²¹ Yet the technology and especially the manufacturing processes remained unproven and immature. Successful completion of the Japanese CFC wing program, along with the development of economical manufacturing methods, carried the potential of propelling Japanese industry from its position as a licensed producer of foreign designs to the forefront of world airframe developers.

The MELCO Active Phased-Array Radar

The last and perhaps least well-known area of military technology for Japan's future fighter that TRDI focused on in the early 1980s was the development of an APA fire-control radar and other key fighter avionics systems. Although the MELCO APA radar became a key area of interest along with MHI's composite wing during the FS-X controversy, few details about its development are available in open sources. Nonetheless, it clearly represents one of the most dramatic modern achievements by Japanese industry in advanced military technology.

In the late 1970s, the major Japanese electronics firms had become increasingly interested in defense production and R&D. By 1980, the top six Japanese defense contractors included three major electronics firms: MELCO, Toshiba Electronics, and Nippon Electronics (NEC). In that year, the JDA awarded these three firms nearly 700 separate military contracts (Kazuo, 1982). Much of this work involved licensed production of American military electronics systems. But by the early 1980s, Japanese electronics firms were moving increasingly toward indigenous development of military electronics. This trend accelerated with the decision to develop indigenously most of the major avionics systems for the XSH-60J helicopter and XT-4 trainer programs. As a result of these programs, JAEI became one of the leading Japanese developers of military avionics systems.

By 1980, however, MELCO had become by far the largest supplier of military electronics to JDA, with over twice the value of contracts of its closest competitor, Toshiba Electronics (Kazuo,

²¹The collaborative EFA, which commenced development in the late 1980s, drew heavily on the CFC wing technology developed for the EAP. See Haresceugh et al. (1990); and Shifrin (1991).

1982). One of the most ambitious and technically demanding programs MELCO undertook in the early 1980s was the development of an APA radar using GaAs MMIC T/R modules for the future Japanese fighter. Japanese government and industry officials have revealed very little information publicly about this program. As discussed in considerable detail in Chapter Two, members of the Pentagon's TAT that visited Japan in July 1984 were surprised to learn about the existence of this R&D effort, but they gleaned few details about it from their Japanese hosts. During the TAT's return visit in April 1985, MELCO officials apparently refused to discuss their APA radar program at all. Several years later, however, JDA disclosed that it had started the program with MELCO in 1981.²²

Undoubtedly, MELCO's development effort benefited from earlier radar licensed-production programs and other contacts with Western firms. Westinghouse Electronics, a major supplier of tactical fighter radars to the U.S. military, cultivated a close relationship with MELCO after the Second World War. Some industry observers report claims that Westinghouse had some involvement with the MELCO APA radar development program.²³ MELCO could also draw on its strong commercial base in GaAs devices and other electronics technologies. In addition, it appears that JDA and MELCO committed substantial resources and effort going back many years before the commencement of the fighter radar program in 1981 to investigating APA technology. According to Japanese press accounts, MELCO also spent about ¥100 billion of its own money during the 1980s and early 1990s to develop the APA military radar technology.²⁴ This impressive effort would result in a full-scale engineering test model of an APA fighter radar ready for flight testing by early 1987.²⁵ This achievement put Japanese industry far ahead of the experienced military avionics developers in Europe—who had not even begun APA radar development—and

²²"Mitsubishi Developing New Radar and Associated Weapons System" (1987); "Defense Agency to Enter Detailed Design Phase of APA Radar" (1987).

²³At least one TAT member recalls a conversation in the mid-1980s with a high-level Westinghouse official who allegedly made such a claim. Interview, Dr. Barry Spielman, October 13, 1992.

²⁴*Nihon Keizai Shimbun*, January 26, 1993.

²⁵"Defense Agency to Enter Detailed Design Phase of APA Radar" (1987).

made the Japanese competitive with the United States in many technical areas related to APA radars.

Thus, by the mid-1980s, Japanese industry and TRDI had made remarkable progress in establishing the technological and organizational foundations necessary to support full-scale development of an indigenous fighter. This achievement had been accomplished without the support of large-scale military R&D funding, by drawing heavily on the capabilities acquired through licensed production of some of the most advanced U.S. military systems, such as the F-15, and by spinning on technologies and capabilities acquired in the commercial sector. TRDI had carefully targeted its limited funds at the areas that could only be developed through dedicated military R&D efforts. It had addressed the perceived weakness of industry in military avionics development and system integration through the F-4E*Jkai*, XSH-60J, and XT-4 programs. Another example of this type of program is the Mitsubishi T-2CCV effort to investigate new fighter maneuvering regimes and FBW technologies. Other technologies with dual-use applications, such as advanced CFC aircraft structures, were developed in parallel through military programs sponsored by TRDI and civilian programs sponsored by NAL, both of which benefited from commercial spin-ons. In the case of APA radar technology, TRDI committed to a long-term dedicated military R&D effort for system development that drew heavily on commercially developed technologies, experience gained from military licensed production, and possibly outside assistance. The net result was a credible overall capability to develop the Rising Sun fighter on a national basis, with the exception of the engine, as determined by TRDI in the spring of 1985.

**THE BATTLE JOINED: STOPPING THE
RISING SUN FIGHTER**

INTRODUCTION

In the summer of 1985, the U.S. government began a systematic effort to forestall Japanese development of an indigenous fighter. This effort was spurred on by heavy lobbying by U.S. defense contractors, as well as growing political pressure from Congress for greater Japanese defense burden-sharing. The Pentagon leadership feared that a Japanese decision to develop its own fighter, instead of purchasing or license-producing an American aircraft, would arouse intense opposition in Congress because of the ongoing trade frictions with Japan. DoD officials primarily opposed indigenous development, however, for high-level military and strategic reasons. Initially, the issues of technology reciprocity and access to Japanese technology played no role at all.

In mid-1985, few at the Pentagon anticipated that it would take nearly two and a half years of difficult and often frustrating negotiations before the Japanese agreed to drop their plans for an all-national fighter. Rejecting the use of heavy-handed political pressure or the linkage of security and trade issues, the Pentagon initially believed Japanese officials would clearly see the obvious benefits of the proposed American approach, particularly when provided with the appropriate technical and cost data. However, U.S. officials grossly underestimated the commitment of the *kokusanka*¹ supporters to indigenous development and their influence over Japanese government policy. The Japanese supporters of a

¹*Kokusanka* is the Japanese term for the policy of seeking autonomy in arms production, as defined by M. Green (1990), p. 2.

national fighter fiercely resisted the American proposals for a cooperative program. Confronted with this resistance, the Pentagon doggedly stuck to its initial strategy of using technical data and cost analyses to convince the Japanese government that the U.S. position was the most rational and sensible approach. In the end, however, this strategy failed. Ultimately, the U.S. side resorted to political pressure on the highest levels of the Japanese government to get an agreement. Embittered by the "sellout" by the political leadership, the *kokusanka* supporters remained determined to achieve as many of their original objectives as possible within the context of a collaborative program with the United States.

The period between June 1985 and October 1987, when Japan finally agreed to develop the FS-X cooperatively with the United States, can be roughly divided into two periods. Up through the end of 1986, the Pentagon and U.S. contractors struggled merely to block final approval by the Japanese government of an indigenous fighter R&D program and to convince Japan to consider seriously a jointly developed U.S. fighter modification as a viable alternative. Confronted with the formidable resistance put up by the *kokusanka* supporters, the American side was pushed into offering increasingly radical modification design proposals in the hopes of enticing Japanese government and industry officials into participating in a joint venture. The Pentagon and U.S. contractors believed proposals for more extensive modifications would prove more attractive to Japanese industry. In the vain hope of attracting Japanese interest, the American side eventually proposed such radically modified variants of U.S. fighters that the resulting R&D effort would approximate development of an all-new fighter.

All of the U.S. design proposals, however, were versions of existing U.S. industry concepts that had been developed for consideration by the American armed forces, as well as other allies. The unspoken American assumption remained that U.S. contractors would dominate the technical aspects of any joint design and development effort no matter how radical and that the resulting aircraft would be equipped largely if not entirely with American subsystems and components. Indeed, burden-sharing remained an important Pentagon justification for collaboration with Japan on such designs, because Japanese funding would contribute to the development of new versions of American fighters of interest to the U.S. services and other allies.

Yet the *kokusanka* supporters were not interested in jointly developing American modification concepts under U.S. industry tutelage, no matter how much new R&D they entailed. For the previous 15 years, Japanese industry and TRDI had been developing their own technologies, subsystems, and design concepts for their own national fighter. Consequently, the Japanese continued to resist all American overtures. During this first period, American government and industry officials remained generally unaware of, or skeptical about, Japanese claims regarding their aerospace technology, subsystem development, and ability to develop a national fighter.

The second period stretches from late 1986 to the end of 1987. During this period, the American side turned increasingly toward direct political pressure and began to link the FS-X question to broader trade issues. Through the early months of 1987, the advocates of indigenous development in Japan began to realize that the Americans were succeeding through political pressure in weakening the resolve of the Japanese political leadership to continue support for an all-national fighter. After this point, the *kokusanka* supporters turned increasingly toward a new strategy of emphasizing the extensiveness and superiority of Japanese designs, technology, and subsystems for a national fighter and demanded that they be fully incorporated into any jointly developed fighter. As related in the next chapter, this strategy proved remarkably effective, laying the foundations for the later transformation of the cooperatively developed FS-X into a Japanese-dominated R&D program and raising the whole contentious issue of technology flowback and access to Japanese technologies, which would later plague the joint R&D effort.

This chapter, however, recounts the events of the first period, from mid-1985 to late 1986, when the American side focused almost exclusively on merely stopping Japanese government approval of an indigenous FS-X and convincing the Japanese to take U.S. proposals for collaboration seriously.

BACKGROUND: U.S. INDUSTRY CONFRONTS A SHRINKING GLOBAL MARKET

By the mid-1980s, the global migration of aerospace technology, facilitated in part through U.S. coproduction and codevelop-

ment programs, and the resulting initiation of new indigenous fighter development programs led many industry observers to predict a long-term catastrophic decline in the traditional global fighter market for U.S. companies. One well-publicized market study predicted a two-thirds reduction in demand in a major sector of the world fighter market between 1995 and 2010, compared to the 15 years from 1980 to 1995. One senior aerospace official at the time went so far as to claim that new foreign indigenous fighter programs had "virtually eliminated the massive export market."²

Two of America's leading fighter contractors, General Dynamics (GD) and McDonnell-Douglas, clearly recognized in the mid-1980s that the global market was dramatically changing. In the 1970s, these two companies had emerged as the leading fighter developers for the U.S. Air Force and Navy. GD's multirole F-16 was on its way to becoming the most numerous fighter type in the U.S. Air Force inventory after its selection in 1975. The McDonnell-Douglas F-15 Eagle remained the premier U.S. Air Force air-superiority fighter. The Navy authorized full-scale development in 1976 of the McDonnell-Douglas F-18 Hornet (developed jointly with Northrop) as its newest fighter, and the U.S. Marines selected the same firm's AV-8B Harrier in the early 1980s.

Both companies originally had strong expectations for substantial foreign sales. Five months after U.S. Air Force selection of the F-16, GD won the "fighter deal of the century" against France's Dassault when Belgium, the Netherlands, Denmark, and Norway agreed to the purchase and collaborative production of the fighter. Iran also placed a major order in 1976. By the end of the decade, GD was heavily targeting Israel, Turkey, Australia, and Canada, as well as Japan, as likely sales prospects. McDonnell-Douglas followed up on the dramatic export successes of its earlier F-4 Phantom with sales of its F-15 in the 1970s to Japan, Israel, and Saudi Arabia. McDonnell-Douglas and Northrop planned a special export version of the F-18 and hoped it would meet with widespread success on the global market.

However, by the early mid-1980s, the two firms began to perceive that both the domestic and foreign markets were substantially contracting and that serious new competitors were emerging overseas. A key component of the problem was an increasingly

²"Crowded Skies" (1987).

overcrowded field of competitors at home and a decline in the domestic market. Because of escalating costs and multiple competing demands on the defense budget, DoD envisioned at most only one major new fighter development program and one tactical attack aircraft program for the 1980s and 1990s: the Advanced Tactical Fighter (ATF) and the Advanced Tactical Aircraft (ATA). At least eight U.S. prime contractors were in the competition for these two development efforts: GD, McDonnell-Douglas, Lockheed, Northrop, Boeing, Grumman, Rockwell/North American, and LTV.

The U.S. Air Force launched the ATF program in 1981 with a Request for Information to U.S. prime contractors. At the same time, the U.S. Navy was examining the possibility of seeking a new common fighter (labeled the VMFX) to replace both the Grumman F-14 fighter and the Grumman A-6 attack aircraft. In 1983, the Navy dropped this approach as too expensive and replaced it with a new plan to upgrade existing F-14s and A-6s and to procure a new attack aircraft, called the ATA. Thus, after 1983, U.S. contractors could expect only one major development program for a new air-superiority fighter and one other program for an attack aircraft over the next several decades. In September 1985, the Air Force sent out Requests for Proposals (RFPs) for a demonstration and validation (dem/val) phase for the ATF. Seven prime contractors responded with design proposals. DoD and the U.S. Air Force selected Lockheed and Northrop in October 1986 to lead competing teams during the dem/val stage of the ATF development program. However, only one team would receive the final award for full-scale development.³ In 1986, the Navy also awarded competitive design contracts for the ATA to two teams: one led by Northrop and one led by McDonnell-Douglas.⁴

With only two domestic fighter-attack programs likely to be funded over the next couple of decades, many U.S. prime contractors looked increasingly to foreign markets to help preserve their fighter business base. This was particularly true for GD, after it failed to win a lead position on either of the ATF or ATA teams.

³Lockheed led a team that included Boeing and General Dynamics. Northrop teamed with McDonnell-Douglas. In April 1991 DoD selected the Lockheed team to continue into full-scale development. See Braybrook (1991).

⁴The Northrop team included LTV and Grumman. Ironically, McDonnell teamed with GD on the ATA, even though they were on opposing teams for the ATF competition. Sweetman (1990).

McDonnell-Douglas was also unable to capture a lead role on either of the two teams competing in the dem/val phase for the ATF, the most prestigious and most likely to be continued into full-scale development of the two programs. Unfortunately, industry studies also indicated that global competition for shrinking foreign markets would become increasingly fierce. Three new proposed fighters under consideration for development in Europe, the collaborative EFA, the French Rafale, and the Swedish Gripen, threatened not only to cut U.S. firms out of the historically lucrative European fighter market but also promised to provide intense competition in other world markets.

In response to these developments, GD began preliminary design studies in 1983, supported by the U.S. Air Force, of possible modified and upgraded versions of the F-16 designed to be effective but affordable for the increasingly financially constrained U.S. services and to be highly competitive against the new European fighters on world markets (Shifrin, 1987). GD hoped that one of these design proposals for a modified F-16 might serve as a leading candidate for a relatively low-cost supplement to the ATF in the future Air Force inventory. With an initial planned buy of only about 750 ATFs envisioned for 1995 through 2010, many remaining older F-4s and F-16s in the huge U.S. Air Force inventory would still need replacement or upgrading. With U.S. Air Force R&D and procurement funds stretched to the limit with the ATF and other procurement programs, GD expected that a relatively inexpensive modified aircraft based on the F-16 would have the best chance of gaining approval as a low-end supplement to the ATF. GD also anticipated that an upgraded F-16 could be a cost-effective competitor on the global market against the expensive new European fighters. McDonnell-Douglas soon adopted a similar strategy and launched preliminary design studies of upgraded versions of its F-18 Hornet (Sweetman, 1988).

But the U.S. companies now faced a new problem in addition to the entries of their traditional European competitors. By the early 1980s, U.S. firms saw their traditional non-European foreign markets slowly contracting as more and more countries planned indigenous fighter development programs or demanded greater co-production or codevelopment offsets from U.S. firms in place of off-the-shelf purchases. Particularly troubling to GD was the case of Israel, which had been a major potential customer for the F-16 in

the late 1970s. In the summer of 1982, Israel launched full-scale development of its own indigenous Lavi fighter, heavily subsidized by U.S. military aid funding. This setback for GD occurred shortly after it had lost its expected sale to Iran following the overthrow of the Shah. Also in 1982, GD's hopes of selling F-16s to Taiwan were dashed by the signing of the U.S.-China Shanghai Communiqué, which called for reduced U.S. military arms transfers to the Nationalist forces. Even worse, Taiwan responded to the Shanghai Communiqué by launching its own program to develop its own indigenous Ching-Kuo fighter. In the place of a hefty off-the-shelf sale, GD had to settle for a consultant role on Taiwan's indigenous program. India also laid plans to develop its own fighter, the Light Combat Aircraft, at this time.

The competition between the two leading U.S. fighter developers, as well as against the leading European contractors, for what remained of the shrinking foreign market became fierce indeed. This intense competition led inevitably to bidding wars that drove Western contractors to offer increasingly greater amounts of production work and technology. Unfortunately, the resulting trend toward greater technology transfer to foreign countries through collaborative programs appeared likely to lead to further contractions in the market in the future by promoting the emergence of new competitors.

For example, in the early 1980s, Turkey demanded and received substantial domestic production and industrial offsets for selecting the F-16 as its next fighter. To win the Turkish sale, GD had to agree to build a smaller-scale duplicate of its huge F-16 manufacturing facility at Fort Worth in a barren field outside of Ankara. In the past, Turkey had gladly accepted off-the-shelf fighters, even used aircraft. Discussions with Korea and other potential F-16 customers made it increasingly clear that Turkey's demands were not unique. GD successfully sold a batch of F-16s to Korea in the early 1980s, but as the decade progressed, McDonnell-Douglas seemed to be winning the competition for licensed production of a larger follow-on order through generous offers of production and technology offsets. After a fierce competition, McDonnell-Douglas also beat out GD in the mid-1980s for major fighter sales, accompanied by substantial offsets, to Canada and Australia.

It was against this background of increasingly constrained U.S. military procurement budgets and dramatically escalating glob-

al competition for shrinking markets that GD and McDonnell-Douglas launched a major lobbying offensive to stop an indigenous Japanese fighter program in 1985. Since World War II, Japan had been one of the most lucrative and reliable foreign markets for U.S. fighters. GD had begun marketing its F-16 Fighting Falcon fighter to the Japanese in the late 1970s.⁵ McDonnell-Douglas, the European Panavia consortium, and other fighter developers also launched sales efforts as the ASDF's determination to seek an early replacement for the disappointing F-1 became widely known. American and European manufacturers of jet engines, radars, and other major fighter subsystems soon joined the prime contractors in pressing their wares on the Japanese.⁶ These marketing efforts remained rather low visibility and routine during the early 1980s as the various factions in the Japanese defense establishment debated options for replacing the F-1.

All this changed when American industry heard of the initial results of the TRDI study reported to the ASDF in April 1985 supporting indigenous development of the FS-X. By June, senior officials at the two U.S. firms had concluded that Japan had definitely decided to proceed with an indigenous FS-X. Indeed, Japanese officials had approached GD directly for assistance in developing their indigenous design. The two American companies decided to lobby the U.S. government directly to pressure the Japanese government to reconsider purchase of a U.S. aircraft. Both companies wrote letters to Secretary of Defense Caspar Weinberger, Secretary of State George Schultz, and Secretary of Commerce Malcolm Baldrige. The letters argued that only decisive intervention by the U.S. government could prevent the Japanese from going ahead with indigenous development, thus denying U.S. contractors a major sale and ultimately contributing to the emergence of a formidable new fighter aircraft competitor on the already overcrowded global market.⁷ Company representatives

⁵Statement of Herbert Rogers, President and CEO, General Dynamics Corporation, in House (1989c), p. 172.

⁶"Turbo-Union Promotes Air-Combat RB.199" (1983); "Westinghouse FCS for FS-X?" (1984).

⁷Testimony of James Auer before the U.S. House of Representatives Committee on Energy and Commerce (Auer, 1989a, p. 90). Auer was the Special Assistant for Japan in the Office of the Assistant Secretary of Defense for International Security Affairs from 1979 through 1988.

also heavily lobbied Congress and officials in DoD's DSAA and elsewhere in the U.S. government.

THE U.S. GOVERNMENT ENTERS THE FRAY

The U.S. domestic political scene in mid-1985 provided a receptive environment for the lobbying efforts of the U.S. fighter contractors. With a high-level meeting planned in June between Secretary Weinberger and Koichi Kato, Director General of the JDA, Congress focused its attention on trade frictions with Japan and on demands for greater defense burden-sharing. In that month, the Senate passed a resolution, also passed by the House of Representatives in July, demanding that Japan spend more on its own defense and accept additional regional military responsibilities. This meant buying American weapon systems. As a *Chicago Tribune* reporter summed it up at the time,

Congress sees [increased Japanese defense spending] as a way to scale back America's ballooning trade deficit with Japan, especially if Tokyo begins buying American military hardware.⁸

Weinberger met with Kato in early June in Washington against this backdrop of renewed congressional pressure on Japan.⁹ The two defense chiefs discussed Japan's slow progress toward fulfilling the new SDF mission role of sea-lane defense agreed to by Prime Minister Suzuki in May 1981. Weinberger also pressed Kato strongly on the issue of defense technology reciprocity. The "Detailed Arrangements for the Transfer of Military Technologies" had finally been accepted by Japan only the previous December after two years of difficult negotiations (see Chapter Two). At the June meeting, Weinberger discussed the U.S. Army's interest in gaining access to the Toshiba Keiko SAM seeker-head technology and possible Japanese participation in SDI (Browning, 1985). Kato remained noncommittal, but later assured critics back home that Japan would require much more information on America's SDI planning before deciding whether to cooperate.¹⁰ After

⁸"Japan Moves Slowly, Surely on Old Foe's Order to Rearm" (1985).

⁹"Weinberger Holds Talks with Japanese Official" (1985).

¹⁰"Japan Moves Slowly, Surely on Old Foe's Order to Rearm" (1985).

their meeting, Weinberger still had little to show Congress from his efforts at acquiring Japanese technology after four years of direct discussions with senior Japanese defense officials. During his stay in Washington, Kato also met with Secretary of State Schultz and with members of Congress. Congressional leaders made it clear to the Director General their growing impatience over the issues of burden-sharing and technology reciprocity.

Military and Strategic Reasons Behind the Pentagon's Opposition

It was in this politically charged atmosphere that Secretary Weinberger received the letters from GD and McDonnell-Douglas requesting vigorous action against the launching of a Japanese indigenous fighter development program. Economic and trade issues, however, were not at the heart of DoD's concerns vis-à-vis Japan. The primary objective of the senior DoD leadership at this time was to maintain and strengthen the existing U.S.-Japan security relationship by ensuring American government and industry involvement in the most important Japanese military procurement program of the 1990s. DoD policymakers viewed independent indigenous development of a world-class fighter by Japan as weakening the Japanese contribution to the joint defense of both countries' shared interests in the short term and undermining the basic nature of the U.S.-Japan security relationship in the long term.

In the first instance, U.S. officials argued that indigenous development would be highly inefficient militarily. Based on past U.S. R&D experience and DoD's assessment of Japanese industry experience, U.S. officials believed a Japanese fighter would cost far more to develop and procure than a comparable U.S. fighter and would be militarily less capable. Indigenous development would siphon off substantial funds from the limited Japanese defense budget critically needed for other important equipment procurement programs. Furthermore, an independently developed Japanese fighter might not be interoperable with U.S. fighters and

other forces operating in the region, thus complicating combined operations and support.¹¹

In the second instance, further development of a domestic military industrial base could be viewed as supporting a more independent and autonomous Japanese security policy in the future. This could have profound implications for future regional stability and the overall U.S.-Japan relationship. DoD officials were also concerned about weapon proliferation problems stemming from increased pressure on the Japanese government by the emerging defense industries to permit unconstrained export of military systems and technology.¹²

Weinberger Rejects High-Pressure Tactics

Senior Pentagon officials, therefore, opposed indigenous development of the FS-X but primarily for military and strategic reasons, not economic ones. Furthermore, Secretary Weinberger; Richard Armitage, Assistant Undersecretary of Defense for International Security Affairs; and James Auer, DoD Special Assistant for Japan, all agreed that applying heavy-handed pressure on the JDA or explicitly linking the FS-X problem to trade frictions could provoke resentments that would damage the U.S.-Japan security relationship and prove counterproductive to U.S. strategic interests. They chose a more subtle strategy of providing the JDA with extensive cost and performance data on U.S. aircraft and information on U.S. regional threat assessments and mission requirements. They were confident that, when presented with this information and reminded of the political mood of Congress, the Japanese security establishment would ultimately choose the rational option that offered Japan the most military capability for the least cost: licensed production of an American fighter (possibly

¹¹For example, see testimony of Secretary of Defense Dick Cheney before the U.S. House of Representatives, Committee on Foreign Affairs (House, 1989c, pp. 53, 56).

¹²Interview with Assistant Undersecretary of Defense Armitage in "Military Power: Ultimate US-Japan Friction" (1990).

modified somewhat to meet specific ASDF requirements). As James Auer told a MITI official at the time when asked if the United States would pressure Japan to buy an American fighter rather than developing a domestic design: "Yes, we are going to pressure you by not pressuring you."¹³

Secretary Weinberger launched this strategy against a domestic FS-X in a discussion with Director General Kato soon after receiving the letters from GD and McDonnell-Douglas. According to a later account by James Auer, Weinberger asked Kato directly whether Japan intended to develop an indigenous fighter as a replacement for the F-1. Kato assured the U.S. Defense Secretary that indigenous development was only one of three options under consideration by JDA and that no final decision had yet been made. The Director General explained that the other two options were licensed production of the GD F-16 or McDonnell-Douglas F-18 and modification of F-4EJs already in the ASDF inventory combined with production of additional F-15s. Weinberger reportedly told Kato that DoD respected Japan's right to make this critical national security decision on its own without U.S. interference or pressure. However, the Secretary of Defense offered to provide Japan information to help it make that difficult decision, including performance and cost data on U.S. fighters, the kinds of cost and technical difficulties Japan could expect to encounter in the demanding task of fighter development, and problems experienced by allies on similar programs, especially Israeli development of the Lavi. Weinberger also reportedly reminded Kato of the restive mood of Congress about the U.S.-Japan trade balance and other trade frictions but emphasized that the decision was Japan's to make.¹⁴

Weinberger's initial discussion with Kato appears to have had some influence on the FS-X decision process. Following TRDI's study confirming the capability of Japanese industry to develop an indigenous fighter, the Air Staff Office (ASO) of the ASDF established an FS-X program office to more carefully examine the three procurement options outlined by Kato to Weinberger. For the

¹³Testimony of James Auer before the U.S. Senate Committee on Armed Services (Auer, 1989b, p. 43). Also see Armitage (1986).

¹⁴James Auer testimony (Auer, 1989b, pp. 47-48); and unpublished lecture by James Auer delivered at the University of Southern California, June 22, 1989.

licensed-production option, the ASO had initially considered up to 15 candidate foreign fighter aircraft. By October 1985, the list had been narrowed down to three aircraft: the F-16, the F-18, and the collaboratively developed European Panavia Tornado (Ebata, 1986, p. 214). The following month, the FS-X Program Office sent out detailed questionnaires to DoD and the Panavia consortium requesting extensive data relating to the licensed production of the airframe, engine, and radar of the three fighters. As the DoD agency responsible for U.S. foreign military sales, the DSAA handled the Japanese request (Button, 1989a).¹⁵

DSAA immediately acted to facilitate a coordinated response to the Japanese request among the relevant working-level DoD authorities, the State Department, the Air Force and Navy, and U.S. industry, based on the general guidelines already established by Secretary Weinberger and the other senior DoD leadership. Provisions were made to provide the requested data to the Japanese on licensed production of existing models of the F-16 and F-18 by the end of January 1986 (Button, 1989a, pp. 5-6). In the first two months of 1986, GD and McDonnell-Douglas marketing teams visited Japan after consulting with DoD on possible proposals to the Japanese. GD offered the basic U.S. Air Force F-16C (Bloc 30/40) for purchase or licensed production.¹⁶

The U.S. industry teams found out, however, that indigenous development of the FS-X remained the strongly favored option in Japan. In September 1985, General Shigehiro Mori, the head of the ASDF, had released the final version of the TRDI report assessing Japanese industry capabilities. This report provided new cost data that bolstered the case of the supporters of an indigenous FS-X. It included a new estimate of development costs that was substantially below earlier cost figures developed by MHI.¹⁷ Moreover, the report projected a unit production cost for an indige-

¹⁵CAPT Andrew Button (USN) was the principal DoD action officer assigned to the FS-X from November 1985 to August 1988; his paper provided the most detailed published account openly available of DoD working-level actions during this period on the FS-X.

¹⁶Interview with a senior U.S. industry official, August 4, 1992.

¹⁷MHI's earlier estimates put development costs at a minimum of ¥200 billion. The TRDI report released in September 1985 calculated development costs at between ¥150 and 200 billion (about \$600 to 800 million at 1985 exchange rates). See Kohno (1989); "Japan: Debate over New Fighter" (1985).

nous FS-X of only about *half* the current cost of F-15s produced under license in Japan.¹⁸ Armed with these cost estimates, advocates confidently pressed their arguments that a domestically developed FS-X would cost substantially less than licensed production of a U.S. fighter, in addition to providing the most industrial and technological benefits to Japan of the three options under consideration. Furthermore, advocates pointed out that, unlike licensed production, indigenous development would produce a fighter tailored precisely to the operational requirements of the ASDF. Since the option of upgrading the F-4EJ had never been considered a serious contender, indigenous development seemed certain to win the competition without further U.S. intervention. Indeed, this was the consensus view among Japanese policymakers at the time (Kohno, 1989, pp. 458-459).

Japan Stresses Its Advanced Fighter Technologies

To dispel U.S. skepticism about the capability of Japanese industry to develop an indigenous FS-X, Japanese officials began publicly revealing some information on the wide range of TRDI- and industry-sponsored military technology research programs that had been under way for some time in support of domestic fighter development. Prior to 1986, aerospace press accounts contained only the vaguest of references to Japanese R&D programs for advanced fighter subsystems and technologies. Indeed, many U.S. subsystem contractors had long assumed that even an indigenous FS-X developed by Mitsubishi would incorporate mostly American subsystems, components, and technologies.¹⁹ Reversing their previous policy of strict secrecy, Japanese officials began by early 1986 to openly discuss their programs to develop primary airframe structures entirely out of composite materials, low-

¹⁸The TRDI report estimated unit production costs at between ¥5.3 and 5.8 billion. If development expenditures were included, unit costs were projected to range from ¥6 to 7 billion, depending on the size of the production run. The price of the F-15J in 1986 was about ¥10.5 billion for a planned production run of 100, including license fees but excluding government-supplied equipment. See Ebata (1986), p. 216.

¹⁹For example, Westinghouse was actively marketing its APG-68 fire-control radar to the Japanese for an indigenous FS-X in 1984. See "Westinghouse FCS for FS-X?" (1984).

observable (stealth) technologies, and new aerodynamic maneuvering modes derived from their research on CCV technologies. They publicly confirmed (apparently for the first time) the existence of programs for developing an APA fire-control radar and an advanced central computer system.²⁰

These revelations were not just to demonstrate Japanese technological competency to develop an advanced fighter. Japanese officials also used them to bolster their arguments against acquiring existing U.S. fighters based on "old" technology. The F-16 and F-18 had been developed with the technologies of the 1970s. The Japanese now pointed to their ongoing domestic R&D programs to develop a new generation of fighter technologies and asked why they should be expected to defend themselves in the late 1990s with a fighter developed 20 years earlier. In short, the *kokusanka* supporters began arguing that not only did Japan possess the technological capabilities to develop its own fighter but such a fighter would incorporate more advanced technologies than currently available on existing U.S. fighters.²¹

THE PENTAGON PROPOSES MODIFICATION OF A U.S. FIGHTER

U.S. industry and government officials generally remained highly skeptical of Japanese claims about the advanced state of their fighter technology development. Nonetheless, such arguments contributed to the growing conviction among U.S. officials in early 1986 that the Japanese would never agree to license-produce an existing U.S. fighter, much less purchase one off the shelf. The Japanese already appeared to have gone much too far down the road toward indigenous development for it to be reasonable to expect them to acquiesce to such proposals. U.S. officials soon concluded that the only option the Japanese might be convinced to accept was licensed production, possibly combined with some joint development, of a modified or upgraded version of the F-16 or F-18. A modified U.S. fighter might be tailored more precisely to

²⁰"Japanese Near Decision on FS-X as Replacement for Mitsubishi F-1" (1986), pp. 87, 89.

²¹"Japanese Near Decision on FS-X as Replacement for Mitsubishi F-1" (1986), p. 87.

Japanese requirements and, much more important, could provide the prospect of Japanese involvement in some R&D work, possible application of Japanese-developed technology, and potential access to more-advanced U.S. technologies.²² There was even some talk of proposing collaborative development of an entirely new fighter with the Japanese, but officials rejected this option as too costly and as contributing too much to increasing Japanese industry capabilities. Thus, in the initial response to the Japanese request for data on U.S. fighters sent out in late January 1986, the director of DSAA suggested the Japanese seriously consider a modified F-16 or F-18 to fulfill their FS-X requirement (Button, 1989a, p. 7).

This option held a certain attraction for the services, especially the Navy, as well as for the U.S. prime contractors. The Gramm-Rudman-Hollings Amendment calling for a balanced Federal budget had considerably heightened the Navy's concerns over its ability to afford a new fighter, especially after it had already been forced to suspend its earlier VMFX study for replacing the F-14 because of budget constraints. As early as December 1985, the Navy expressed interest to the Pentagon in encouraging McDonnell-Douglas to seek a cooperative program with the Japanese for the joint development of an upgraded F-18 to meet the Navy's future fighter requirements (Button, 1989b, p. 1).²³ GD was also working closely with the Air Force on design proposals for a modified F-16. The U.S. Air Force Tactical Air Command seemed interested in one version called the Agile Falcon. GD froze the configuration of an early design of its Agile Falcon proposal in August 1985 in hopes of convincing the Air Force to support further development. Since the Air Force was going ahead with its costly ATF program, making procurement in the near term of substantial numbers of a second new fighter very unlikely, GD had already targeted its four F-16 customers in Europe as potential collaboration partners on the Agile Falcon or some other upgraded F-16.²⁴ Collaboration with Japan (or with European countries) on one of these programs would mean that the foreign partner would shoulder a significant

²²Although the U.S. team agreed from the very beginning to use the same fairly strict guidelines for technology transfer that applied to the Japanese F-15J licensed-production program.

²³McDonnell-Douglas's design proposals for an upgraded F-18 were called Hornet II, Hornet 2000, and Super Hornet at different points in their evolution.

²⁴Interview with a senior U.S. industry official, August 4, 1992.

percentage of the development costs, thus relieving pressure on the U.S. service's procurement budgets and thus making U.S. procurement more likely. Furthermore, such a strategy responded directly to congressional calls to reduce costs through greater equipment procurement collaboration with allies, as recently formalized through the Nunn-Quayle Amendment.

At this point, however, nobody in the Pentagon or in industry had a good idea of what sort of design proposals for modified U.S. fighters to offer the Japanese. GD's and McDonnell-Douglas's design proposals for the U.S. services were in the preliminary stages, and the Air Force and Navy were far from committing to any one configuration or design. Many of the industry proposals were little more than conceptual studies or marketing tools. Even worse, the U.S. side had only very sketchy knowledge of Japanese performance requirements and technological objectives for the FS-X. The U.S. industry teams had acquired only very general information on FS-X requirements on their visits to Japan. This lack of information made it difficult for DoD and U.S. industry to offer counter-proposals to the indigenous FS-X based on existing U.S. fighters that were competitive with MHI's "paper design," which was presumably already optimized to meet Japanese objectives.

Consequently, in March, the Pentagon requested additional data on FS-X operational and technical requirements from the Japanese. The same month, DoD officials attempted to gain more information directly from the ASDF ASO on these questions and on the general status of the FS-X program during a visit to Japan. The U.S. side again advanced the notion of cooperation on an upgraded U.S. fighter, arguing that such an option would be the most cost effective, would provide the greatest overall improvement in Japanese military capabilities, and would further enhance the U.S.-Japan security relationship. The ASO officials, however, rejected this option outright, insisting that the Diet had already been formally informed of the three official FS-X options JDA had under consideration. Moreover, the Americans gained the distinct impression that the Japanese were clearly committed to proceeding with indigenous development. The U.S. team also failed to acquire much more information on FS-X mission and performance requirements but concluded that little realistic analysis had been conducted either on mission scenarios and operational require-

ments or on the cost of developing a national design (Button, 1989a, p. 8).

Although the U.S. working-level team returned from its trip somewhat discouraged, the U.S. strategy of "pressuring with no pressure" was indeed already having an effect on the higher political levels within the JDA and even at MITI. Like their American counterparts, senior officials at JDA placed the highest priority on maintaining a strong U.S.-Japan security relationship and were increasingly sensitive to the potential threat posed to that relationship by trade frictions. They were also acutely aware of the growing congressional and DoD frustration over the lack of results from the Reagan administration initiatives first launched in 1981 to seek greater equipment collaboration and to gain access to Japanese defense-related technologies. Even some officials at MITI began revising their views on defense technology collaboration and the development of an indigenous Japanese aerospace industry. Starting in late 1985, the argument gained ground in the MITI Aircraft and Ordnance Division that the changing nature of the economic relationship between the two countries, and the growing U.S. demands for increased defense burden-sharing, required Japan to seek greater equipment collaboration with America.²⁵

Consequently, following the receipt of the DSAA letter in January suggesting collaboration on a modified U.S. fighter, the ASO, industry, and other *kokusanka* supporters began feeling pressure from higher political levels at least to include this alternative among the three existing FS-X options. In February, the new head of the ASDF, General Hitachi Omura, announced in a press conference that additional information on foreign fighter programs would be sought prior to a final decision. The next month, the pressure increased after Secretary Weinberger publicly supported the option of collaboration on the FS-X for the first time in a newspaper interview that received widespread attention in Japan. Seiki Nishihiro, Director of the Defense Policy Bureau of the JDA, officially informed the Diet in March that the United States had proposed joint development of the FS-X based on an existing fighter. More important, Nishihiro stated that the official option of domestic development should be viewed as including both indige-

²⁵Kohno (1989), pp. 461-462; "Military Power: Ultimate U.S.-Japan Friction" (1990) pp. 15-16.

nous national development *and* cooperative development with the United States based on the F-16, F-18, or Mitsubishi F-1 (Button, 1989a, p. 12; Kohno, 1989, pp. 401-462).²⁶

JAPANESE WORKING-LEVEL RESISTANCE STIFFENS

Thus, by early spring, senior political levels in the JDA, MITI and elsewhere in the government were clearly trying to demonstrate responsiveness to U.S. suggestions for a collaborative program. However, to the supporters of *kokusanka* in Japanese industry and on the working level in the JDA Equipment Bureau and in the ASO, this apparent shift in government policy proved to be particularly difficult to deal with. Their resistance stiffened to U.S. initiatives for collaboration based on a modified U.S. fighter, as became clear during a visit by the ASDF FS-X Study Team to the Pentagon and six U.S. contractors in May to conduct the first detailed face-to-face discussions on the FS-X program. During this visit, headed by Major General Hossho of the ASO, DoD officials and U.S. industry offered further assistance on assessing the official FS-X options, including data on existing U.S. fighters and examples of possible configurations for modified U.S. aircraft (Button, 1989a, p. 10).

The Japanese visitors, however, raised several problems. First and foremost, they stressed the critical importance to Japan of establishing an indigenous industrial capability to design and develop a national fighter. They observed (with, as it turned out, considerable prescience) that a collaborative program would raise very difficult questions of workshare between U.S. and Japanese industry. Furthermore, discussion of any detailed arrangements for a possible collaboration could not take place prior to a final government decision on the FS-X options. They insisted that a decision had to be made by July 31 because of the established F-1 replacement schedule. Most important, the Japanese visitors declined to provide DoD or U.S. industry with anything other than vague and incomplete information on ASDF performance and op-

²⁶Secretary Weinberger met with Prime Minister Nakasone and JDA Director General Kato in early April, but reportedly applied no direct pressure on the FS-X issue.

erational requirements for the FS-X, thus placing U.S. industry at a considerable disadvantage in the competition. However, they explicitly rejected the F-16 and F-18 as too small and the F-15 as too expensive (Button, 1989a, pp. 11-12).

From the perspective of the DoD working level and U.S. industry, the Japanese visit was disappointing. Although the Japanese government now appeared willing at least to consider the option of collaboration based on a U.S. fighter, the cards seemed heavily stacked against the U.S. entries. DoD and U.S. industry still had no detailed idea of the performance requirements and technical benchmarks against which JDA and the ASO would judge U.S. design proposals. Furthermore, even if U.S. industry had acquired this information, insufficient time remained to work up detailed design proposals. The Japanese had made it clear that all data on U.S. designs had to be submitted by the end of June and that the final decision would be made the following month. Thus, according to CAPT Andrew Button (USN), who attended the DoD meetings in May, it seemed that the Japanese visitors would return home "more determined than ever to recommend a domestic fighter to the Defense Agency." (Button, 1989a, p. 13.)

U.S. CONTRACTORS' INITIAL MODIFICATION PROPOSALS

Still lacking detailed knowledge of ASDF operational requirements and ongoing Japanese industry R&D efforts for an indigenous fighter, the U.S. contractors rapidly put together design proposals for the Japanese that either entailed only modest modifications to their existing fighters or were based on earlier design studies conducted for the U.S. services or for other purposes.

GD generated two different designs for Japanese consideration, as shown in Figure 5.1. The first was a very minimally modified F-16C. It differed from the standard U.S. Air Force fighter only in that it would be equipped with 600-gallon drop tanks for greater range, two additional stores pylons for mounting Japanese antiship missiles, heavy-duty landing gear, and an improved jet engine.²⁷

²⁷Interview with a senior U.S. industry official, August 4, 1992; GD briefing charts reproduced in Button (1989a), Appendix B, p. 42A.

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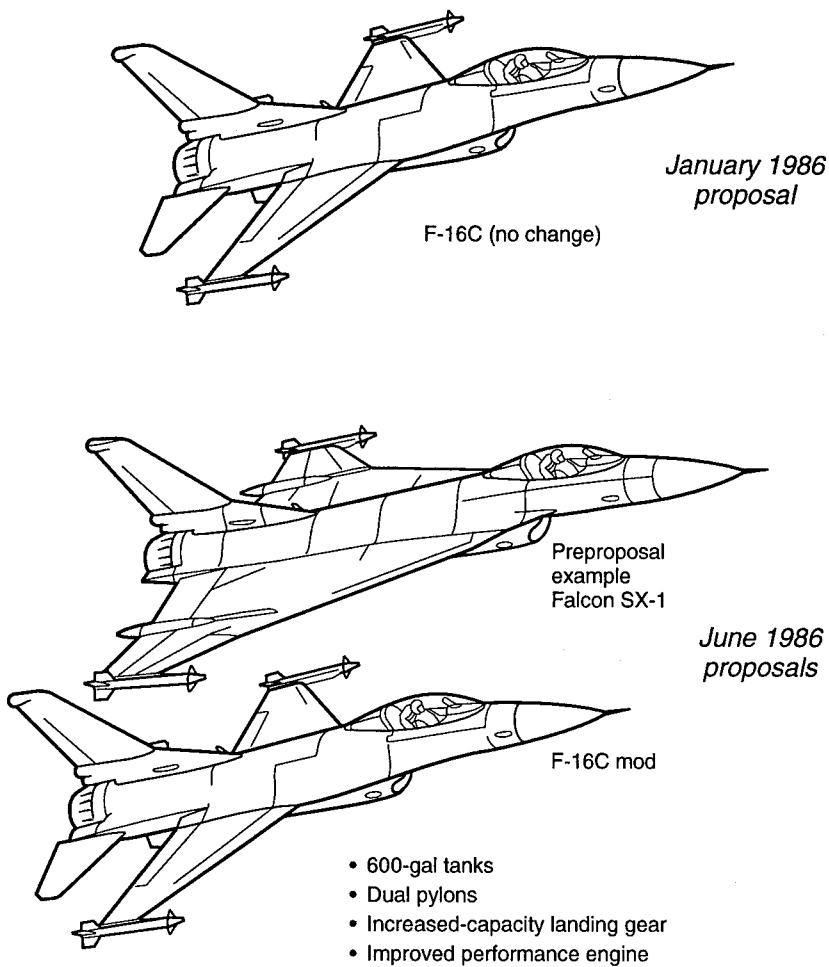


Figure 5.1—Initial GD Design Proposals

The second was a radical modification presented as a “preproposal example” and labeled the Falcon SX-1. The SX-1 proposal was actually a company-funded demonstration prototype called the F-16XL, developed by GD five years earlier and first flown in July 1982. The F-16XL had a dramatically redesigned and enlarged

“cranked arrow” wing to improve cruise efficiency and combat range. GD had hoped the Air Force would select the F-16XL as a new attack-strike fighter, but in early 1984, the McDonnell-Douglas F-15E had been chosen instead. During their visit to Fort Worth in May 1986, General Hossho and his team had been shown the F-16XL prototype and had expressed considerable interest in the aircraft. Based on what little information GD had, the F-16XL appeared to meet or exceed virtually all FS-X requirements.²⁸ Furthermore, it incorporated advanced technology presumably of interest to Japanese industry, such as the graphite/bismaleimide composite skins covering the main wings, which had been manufactured with an automatic tape-laying machine.²⁹ In a similar manner, McDonnell-Douglas also hastily put together several proposals for the Japanese.

On June 30, 1986, U.S. officials hand-delivered these contractor proposals, plus additional requested information on existing U.S. fighters, to Japanese officials in Tokyo. Clearly, the U.S. proposals had little chance of winning the FS-X competition if the decision were left solely to the JDA Equipment Bureau, the ASDF ASO, and Japanese industry. However, on the highest political levels, broader concerns about the possible politicization of the FS-X issue and its effect on the overall U.S.-Japan security relationship were beginning to undermine the position of the working-level supporters of the Rising Sun fighter.

In the summer of 1986, senior Pentagon officials were clearly beginning to run out of patience on the FS-X issue and starting to recognize the need for greater political pressure. Japan, however, was hardly the only target of Pentagon displeasure. At this time, the Pentagon intensified its public opposition to the entire spectrum of allied indigenous fighter programs. A primary focus of this effort was the Israeli Lavi, the most vulnerable of the allied indigenous fighter projects then under way, because it was funded largely by U.S. military aid grants. The Pentagon had originally started a campaign to stop the Lavi project in 1985 around the same time that concerns began to mount over the indigenous FS-X.

²⁸The first design proposal of a minimally modified F-16C also came close to meeting FS-X requirements as GD understood them at the time.

²⁹Interview with a senior U.S. industry official, August 4, 1992; also see “General Dynamics F-16XL” (1986), pp. 411–412.

The controversy dramatically escalated in July 1986, when Secretary Weinberger blocked the release of appropriated funds and demanded that the Israelis participate in a DoD study of U.S. alternatives to the Lavi. The Israeli Defense Minister met with Weinberger and GD officials in September to try to settle the dispute. GD offered the Israelis licensed production of an improved F-16 and assistance in expanding their aerospace industrial infrastructure in return for cancellation of the Lavi. When the Israelis refused, DoD officials turned up the heat and broadened the attack. In a major policy address the same month, Secretary of the Navy John Lehman blasted both the French Rafale and British experimental fighter programs in addition to the Lavi, labeling them expensive "nationalist projects" that were attempting to "re-invent the F-16" at the expense of more important mutual security priorities. This was the first public criticism by a senior Pentagon official aimed against allied fighter development programs (Perras, 1989).

Given this shift of mood in the Pentagon and the example of the increasingly acrimonious dispute over the Israeli Lavi, Japanese officials concluded that some conciliatory gesture toward the United States was in order. In July, JDA added cooperative development based on a U.S. fighter as a fourth official option for FS-X. GD and McDonnell-Douglas immediately followed with official requests to JDA for cooperative programs based on their design proposals submitted on June 30. Against the background of Secretary Weinberger's blunt demands that the Israelis seriously examine U.S. alternatives to the Lavi, JDA extended the deadline for a final decision on FS-X beyond July 31 to permit a detailed evaluation of the design proposals submitted by the U.S. contractors (Kohno, 1989, p. 462).

This key Japanese concession on FS-X, however, did little to alleviate the growing U.S. political pressure on Japan to increase its defense burden-sharing. To senior American officials, greater burden-sharing meant higher Japanese defense budgets, more direct purchases of U.S. military equipment, and increased collaboration and reciprocity in weapon development and defense technology. Vice President Bush and Secretary Weinberger made these points particularly forcefully in September during meetings with Yuko

Kurihara, the newly appointed Director General of the JDA.³⁰ To mollify the Americans, Japan finally announced soon afterwards its willingness to participate in the SDI, first requested by President Reagan almost two years earlier. Furthermore, after many months of delay, Director General Kurihara agreed at this time to permit the transfer of seeker-head technology from the Keiko SAM to U.S. industry as the first concrete result from the "Exchange of Notes" framework for defense technology reciprocity established in late 1983 (see Chapter Two). The Japanese government also proposed a defense budget that for the first time surpassed 1 percent of the nation's GNP (Kohno, 1989, p. 463; also see Chapter Two). In short, the growing U.S. sensitivity over the question of burden-sharing, driven by congressional concern over trade issues, was inexorably pushing the Japanese political leadership to demonstrate a greater willingness to consider U.S. proposals for collaboration seriously, despite the fervent opposition of the *kokusanka* supporters.

NEW U.S. DESIGN PROPOSALS OFFER EXTENSIVE MODIFICATION

Following the meetings in September between Vice President Bush, Secretary Weinberger, and Director General Kurihara, the Japanese leadership realized that, to avoid further political controversy, it had to make a good-faith effort to show it was seriously considering the American FS-X proposals. Consequently, General Hosho of the ASO sent a letter to the Pentagon requesting formal briefings in Tokyo by the U.S. contractors on their collaboration proposals submitted on June 30. The ASO officially delayed the FS-X decision and targeted the end of December for a final source selection. The Japanese scheduled the U.S. contractor briefings for October. However, the American firms still needed more information on Japanese military requirements to refine their initial design proposals. With the approval and encouragement of DoD, GD

³⁰Kurihara had been appointed by Prime Minister Nakasone following the landslide victory in both houses of the legislature in July by the ruling Liberal Democratic Party. The strengthened domestic political position of the LDP actually undermined the *kokusanka* supporters by raising U.S. expectations for greater burden-sharing from the generally prodefense and pro-American Nakasone government. (Kohno, 1989, pp. 462-463).

and McDonnell-Douglas had approached MHI in August 1986 to open industry-to-industry discussions on collaboration prior to the final FS-X decision and to acquire more information on ASDF requirements and on Japanese industry design proposals. Still hoping to win quick approval for its indigenous design, MHI expressed no interest in such discussions (Button, 1989b, p. 8). GD and McDonnell-Douglas thus still had little to go on other than what could be gleaned from the areas of interest indicated in the questionnaires the ASO had sent the Pentagon early in the year requesting information on existing U.S. fighters.

Based on their interactions with the Japanese, however, the U.S. prime contractors concluded their proposals would have little chance of being selected unless they offered major modifications to their baseline aircraft and new technology of interest to Japanese industry. GD realized its two hastily developed submissions in June would prove unacceptable to the Japanese, because the first entailed only minimal modifications and the second (the SX-1) was based on an existing prototype demonstrator (the F-16XL) that had already been designed and developed. Furthermore, the U.S. Air Force was no longer interested in pursuing the F-16XL design concept.

Both DoD and the U.S. contractors strongly opposed pursuing collaborative development with Japan of an *ab initio* design, or development of a radical modification tailored only to meet Japanese requirements, because these options would be too costly, transfer too much technology, and differ little in ultimate effect from indigenous development with U.S. assistance.³¹ To resolve this problem, GD developed two new proposals for the October briefings in Tokyo that were based directly on its Agile Falcon design studies already under way for the Air Force.

GD called its two new additional offerings the Falcon SX-2 and the Falcon SX-3, as shown in Figures 5.2 and 5.3. In outward appearance, they differed little from current F-16s, varying from the baseline F-16C in only two important respects. First, the SX-2 and SX-3 boasted entirely new and enlarged wings with a different as-

³¹Some observers did support genuine collaborative development of a new design as a means of gaining access to Japanese defense-related technologies and expertise. However, this does not appear to have been a central consideration at this time for the Pentagon officials directly involved in the FS-X negotiations. See Rubinstein (1986), p. 20.

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proposals

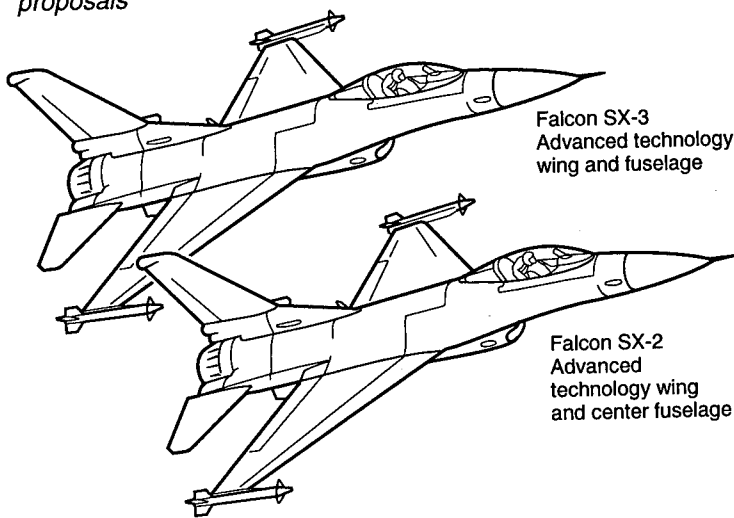


Figure 5.2—GD's SX-2 and SX-3 Proposals

pect ratio and 25 percent more surface area (375 versus 300 ft²). The planform shape, however, remained close to the existing F-16 wing. Second, they incorporated extensive application of advanced carbon graphite composite materials to major airframe structures. The SX-2, labeled as the "minimal modification," used composite materials for the new wing and the center fuselage section, representing 35 percent of the airframe by weight. The SX-3, labeled the "maximum modification," differed from the SX-2 only in the greater use of composites—amounting to 42 percent by weight—by adding composite forward and aft fuselage sections (Button, 1989a, Appendix B, pp. 42B–42D).

The basic design configuration of both these proposals was the same as the initial Agile Falcon design developed for the U.S. Air Force and frozen in August 1985. The wings were the same design and size in both cases. The extensive use of composite materials also directly reflected GD objectives for the U.S. Air Force proposals.³² The SX-2 and SX-3 would be equipped with an upgraded

³²See, for example, Shifrin (1987); "USAF May Develop Agile Falcon Without Allied Participation" (1987).

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	F-16 MOD	Falcon SX-1	Falcon SX-2	Falcon SX-3
Status	Production*	Prototype	Concept	Concept
Wing area (ft ²)	300	663	375	375
Aspect ratio	3.00	1.60	3.75	3.75
Empty weight (lb)	19,200	21,500	20,180	19,430
Internal fuel (lb)	6,972	12,868	7,455	7,455
Air-surface TOGW (lb)	45,220	50,560	46,680	45,930
Air-air TOGW (lb)	38,240	46,980	40,190	39,440
Length (ft)	47.7	52.4	47.7	47.7
Span (ft)	31.0	33.4	38.5	38.5
Height (ft)	16.7	17.6	16.7	16.7

* Except for dual pylon, 600-gal tanks

Figure 5.3—A Comparison of GD's SX Proposals

engine also planned for the Air Force and existing or slightly improved versions of the major F-16 avionics and other subsystems, such as the Westinghouse APG-68 fire-control radar. Thus, GD's offerings focused almost entirely on airframe structural modifications; they were to be equipped entirely with avionics and other subsystems that differed little from those already installed or planned for U.S. Air Force versions of the standard F-16.³³

McDonnell-Douglas pursued a generally similar strategy for the October briefings. Its baseline proposal, called the Super Hornet, consisted of a standard F-18 modestly upgraded with improved avionics, engine, windshield, and air inlet, as shown in Figure 5.4. McDonnell-Douglas engineers, however, also offered a design concept that embodied far more radical changes from its existing fighter than was the case with GD's SX-2 and SX-3 proposals.

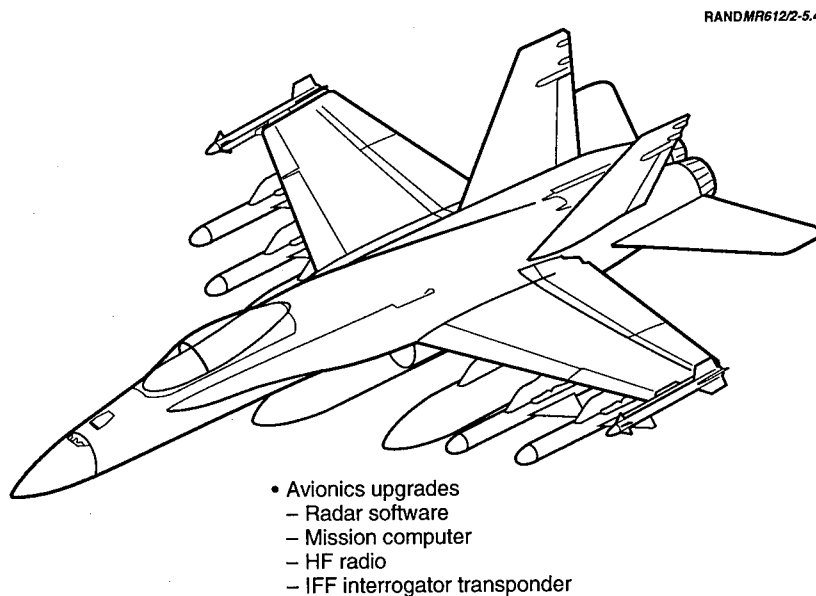


Figure 5.4—McDonnell-Douglas's Super Hornet Proposal

³³Interview with a senior U.S. industry official, August 4, 1992.

Called the Super Hornet Plus, this proposal incorporated dramatically redesigned “cranked arrow” wings, larger vertical tails, canards mounted on the nose to provide unconventional maneuvering capabilities, additional stores pylons, strengthened nose gear, and advanced flight-control modes, as shown in Figure 5.5.³⁴

McDonnell-Douglas developed its Super Hornet Plus concept with an eye to the U.S. Navy’s longer-term fighter replacement schedules and budget constraints and the potential high-end market in Europe. Since the F-18 was a newer fighter than the F-16, targeting existing operators with a relatively modest near-term upgrade proposal, as GD was doing with the Air Force and European F-16 operators, was less likely to achieve success. Unlike the Air Force, the Navy had no ongoing program for a new

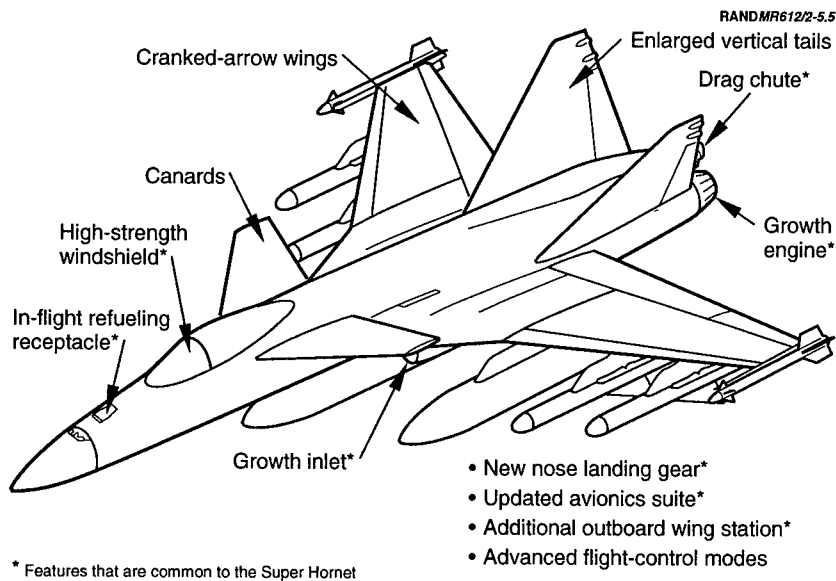


Figure 5.5—McDonnell-Douglas’s Super Hornet Plus Proposal

³⁴McDonnell-Douglas briefing charts reproduced in Button (1989a), Appendix B, pp. 42E, 42F.

first-line air defense fighter and probably could not afford one in the foreseeable future. The Super Hornet Plus offered the Navy the prospect of an extensively upgraded fighter of significantly improved performance at far less cost than a totally new design. McDonnell-Douglas also viewed Super Hornet Plus as the most attractive American alternative to the shaky European development programs for the collaborative EFA and the French Rafale. If one of these programs faltered, which seemed likely, McDonnell-Douglas also reasoned that a dramatically upgraded F-18 developed as the possible future premier Navy fighter could prove to be a tempting substitute. McDonnell-Douglas officials maintained close contacts with British and German air force authorities at this time about such possibilities (Sweetman, 1988).

In short, by October 1986, the U.S. contractors, with DoD encouragement, had developed proposals for the Japanese for extensively modified fighters that offered the prospect of significant new R&D work and technology development. The McDonnell-Douglas Super Hornet Plus proposal came close to an offer for cooperative development on a virtually new fighter. Yet the basic design and configuration of these fighter proposals had been developed by the U.S. contractors in close cooperation with the U.S. services and other American allies. Indeed, one of the principal reasons GD dropped the F-16XL proposal for the Japanese was that the U.S. Air Force had made it clear that it was no longer interested in the design for its own possible use.³⁵ The U.S. side clearly intended to maintain program leadership by exercising tight control on design configuration, technology development, and technology transfer. The American contractors' proposals envisioned major structural changes and a much greater use of composite materials. However, the new modified fighters would be equipped largely with major U.S. subsystems and components. In this way, collaboration could serve as a means of sharing the development costs and work for upgraded fighters that could possibly meet the needs of at least one of the U.S. services and other U.S. allies, as well as those of U.S. industry. Thus, collaboration on one of these design proposals could be viewed as a significant Japanese contribution to burden-sharing with the United States.

³⁵Interview with a senior U.S. industry official, August 4, 1992.

By the end of 1986, prospects for reaching agreement on a mutually beneficial program for cooperative development of FS-X based on a U.S. fighter seemed to be improving. The U.S. side was applying greater high-level political pressure on the Japanese government to increase burden-sharing, while simultaneously enticing Japanese industry with more-extensive modification proposals that included many new technology applications. By the summer of 1986, the tide had clearly begun to turn against the *kokusanka* supporters' dream of independent domestic development of the Rising Sun fighter. The sharp Pentagon attacks against the Lavi and European fighter programs did not bode well for an all-indigenous FS-X. Senior DoD officials were still refraining from directly pressuring their Japanese counterparts on the FS-X issue. But the Japanese political leadership clearly got the intended message that Congress could turn FS-X into another serious trade dispute. Vocal demands from Congress for greater defense burden-sharing from Japan, spurred by the record 1986 U.S. trade deficit and other trade frictions, could not be ignored.

Yet, while clearly on the defensive after the summer of 1986, the *kokusanka* supporters were hardly beaten. The United States had won three major concessions: The Japanese had added collaborative development as an official option, delayed the final FS-X decision beyond July 31, and agreed to consider new U.S. design proposals during contractor meetings in October. All this meant from the U.S. perspective, however, was that the certainty of indigenous development had been somewhat reduced. Over the next 15 months, the *kokusanka* supporters continued to fight tenaciously to save the indigenous FS-X. They increasingly focused on the argument that domestic development would permit the utilization of superior Japanese technology and would result in a lower-cost, higher-capability fighter for the ASDF. To support its case, Japanese industry began revealing even more details about its military R&D programs for developing advanced composite structures and new-generation subsystems, such as MELCO's prototype APA fire-control radar. U.S. industry felt obligated to respond to these revelations to remain in the competition. The American contractors began adjusting their design proposals to accommodate the advanced technologies and subsystems under development in Japan.

Meanwhile, senior U.S. government officials gradually recognized that a collaborative program would never be approved without applying direct political pressure on the highest levels of the Japanese government. The *kokusanka* supporters soon came to the bitter realization that this U.S. strategy would likely work. With their dream of an all-national fighter rapidly fading, they turned to a new and ultimately highly successful strategy of preserving the key technology objectives of indigenous development within the confines of a cooperative program with the United States. The successful U.S. push to impose collaboration on a reluctant partner and the unfolding of the Japanese counterstrategy are recounted in the next chapter.

COLLABORATION IMPOSED

INTRODUCTION

During the second half of 1986, the Pentagon escalated the pressure on JDA to accept collaboration on FS-X. This pressure grew considerably more intense during the first half of 1987, as the political connection between the FS-X, broader U.S. demands for greater defense burden-sharing, and continuing trade disputes with Japan emerged more clearly on the American side. U.S. leverage increased dramatically in the spring of 1987, when the Toshiba scandal caused great embarrassment to the Japanese government over the transfer of sensitive U.S. defense technology to the Soviet Union. Eventually, even the Pentagon dropped all pretense of continuing with the policy of "pressuring without pressure," as DoD officials began explicitly linking a Japanese decision to collaborate to the overall future health of the U.S.-Japan security relationship. The Japanese government slowly but inevitably gave way in the face of this escalating pressure, despite intense opposition from the *kokusanka* supporters.

The Japanese supporters of indigenous development watched with anger and bitterness as their dream of developing the Rising Sun fighter slipped away in the face of relentless U.S. political pressure. As collaboration became increasingly inevitable, however, they developed a fallback strategy of retaining the essential elements of an indigenous development effort within the confines of a collaborative program. The precursor of this strategy emerged as early as the end of 1986, when the *kokusanka* supporters began more heavily emphasizing the extent of Japanese technological preparations for indigenous development in discussions with the

Americans. At this time, the Japanese objective was to counter the Pentagon's technical arguments against indigenous development and to demonstrate why collaboration based on an existing U.S. fighter was unacceptable. Representatives of the *kokusanka* supporters argued that new Japanese technology developments and ongoing subsystem R&D meant that an indigenous fighter would be superior to any upgraded American aircraft. As U.S. political pressure continued to mount, the *kokusanka* supporters began using these same arguments to insist that new Japanese technology and subsystems must be extensively applied to a jointly modified U.S. fighter and that Japanese industry must control the R&D process.

At the end of 1987, the United States succeeded in imposing collaboration on the *kokusanka* supporters. The American side won U.S. government and industry involvement in FS-X, which now would be based on the GD's F-16C. However, as collaboration became increasingly inevitable, the *kokusanka* supporters turned increasingly to the fallback strategy of retaining the essential elements of an indigenous development effort within the confines of a collaborative program. The remarkable success of the counterstrategy pushed by the *kokusanka* supporters would in many respects turn the American success into a Pyrrhic victory. In the summer of 1987, the *kokusanka* supporters had succeeded in convincing GD to accept a wide array of Japanese modifications, technology applications, and subsystems to the baseline American design proposal. Neither the American contractors nor the U.S. government effectively countered the Japanese strategy. Yet the U.S. side clearly sought to minimize modification of the selected American fighter, as evidenced by the Pentagon's pressure on GD to withdraw its even more radically modified SX-4 design proposal. How then did the *kokusanka* strategy succeed?

This chapter recounts the U.S. success in imposing collaboration and the development of the Japanese counterstrategy.

JAPANESE TECHNOLOGY UNVEILED

During a two-week period in October 1986, contractor teams from GD and McDonnell-Douglas, accompanied by representatives from the Pentagon and the U.S. Embassy, briefed their fighter proposals in Tokyo to Japanese officials from the ASO and JDA's

TRDI (see Chinworth, 1992, p. 144; Chuter, 1986). The Japanese hosts also presented a series of revealing briefings that did not bolster the hopes of the Americans. They officially informed the U.S. contractors that cooperative development of a modified U.S. fighter was indeed a formal option under consideration. However, they presented conditions for such a collaboration that gave the Japanese side control over aircraft configuration, technology application, and overall R&D. Furthermore, the Japanese revealed an initial evaluation of the U.S. contractor proposals that concluded that none of the U.S. entries met the Japanese operational requirements. This was hardly surprising, since the U.S. side learned for the first time during these briefings about the FS-X's detailed operational requirements. GD found itself at a particular disadvantage: It discovered that its designs for a modified fighter were entirely unacceptable, because Japanese requirements demanded a two-engine fighter, and all of GD's proposals were single-engine aircraft.¹

Perhaps most important from the perspective of the later evolution of the program, the U.S. participants learned something official for the first time about the long-standing Japanese efforts to develop advanced military avionics systems, such as an APA radar, and the intention to install them in the indigenous FS-X (Button, 1989b, p. 9). Prior to this time, DoD and industry officials do not appear to have taken the vague Japanese claims of advanced technology and subsystem development for their indigenous fighter very seriously. Nearly all American proposals assumed the installation of existing or modestly modified U.S. avionics.²

A central reason for the U.S. skepticism was the nearly total lack of detailed information about Japanese subsystem R&D efforts. It will be recalled that, following the Japanese agreement in 1983 to permit export of defense-related technology to the United States, DoD established TATs to identify Japanese military R&D

¹Since GD's SX-1, SX-2, and SX-3 proposals were closely patterned on the standard single-engine F-16, they too were equipped with only one engine. McDonnell-Douglas's modification proposals retained the two-engine configuration of the existing F-18. (Button, 1989a, pp. 15-16.)

²Although it appears that GD did develop a proposal sometime in 1986 for a minimally modified F-16 airframe that would incorporate "Japan-unique systems." (Interview with a senior U.S. industry official, August 4, 1992; Button, 1989a, Appendix B, p. 42G.)

programs and dual-use technologies of potential interest to the U.S. services and industry. During the first TAT visit to Japan in July 1984 to examine Japanese developments in millimeter-wave, microwave, and electro-optical technology applications, U.S. team members had been given a tantalizing but brief glimpse of some advanced Japanese military electronics developments, including technologies and components for developing APA fighter radar (see Chapter Two).

Prior to this visit, most U.S. industry and government officials were not even aware of Japanese efforts to develop such advanced military electronics. During the follow-on TAT visit to Japan in April 1985, U.S. team members had attempted to find out more about the military radar programs, but had been refused any additional information. Japanese sensitivities about these programs actually seemed to deepen after the second visit. DoD arranged a third TAT visit to Japan in August 1986, two months before the U.S. fighter contractor briefings in Tokyo. One team member on this trip, the chief of microwave device research at the Air Force's Wright Aeronautical Laboratories, set out explicitly to find out more about Japanese development of an APA radar for their future fighter. Similar to the second trip, the Japanese hosts declined to discuss this program or show the visitors any hardware, claiming the team's official charter now focused exclusively on millimeter-wave and electro-optical technologies, not microwave radar developments. During their visit to MELCO, the Japanese prime contractor for the FS-X APA radar, the Americans received gifts of beautifully crafted wood-veneer boxes but learned nothing about fire-control radar R&D. After the visit, the U.S. radar expert commented to the team's JDA escort that the gift was just like the visit: nicely packaged, but with no content.³

The TATs, of course, had been tasked to identify Japanese defense-related technologies for possible DoD application to American defense programs. This initiative was entirely separate from the FS-X issue at this time. The TATs had little or no interaction with DSAA or other U.S. officials negotiating the FS-X problem in late 1986. There was no talk at this time of using FS-X as a vehicle to acquire Japanese technology, because the central U.S. objective was to prevent indigenous fighter development by convincing the

³Interview with Richard Remski, October 20, 1992. Also see OUSDA (1987).

Japanese to cooperate on development of a modified U.S. fighter whose design and development would be dominated by the Americans. Indeed, the Japanese had been funding the radar and other avionics development efforts through accounts separate from the FS-X program. The U.S. contractors had received very little specific information about the alleged "superior" Japanese technology developments in their interactions with Mitsubishi and other firms.⁴ Thus, it appears that the Japanese decided to reveal more information during the October briefings to the U.S. contractors and DoD officials about their avionics development programs to bolster their arguments in support of indigenous development or, at a minimum, cooperative development of a fighter that permitted much greater Japanese technological and R&D leadership.

The U.S. Side Regroups: Delaying the Final Japanese Decision

Following the October briefings in Tokyo, American government and industry officials had to regroup and decide how to continue the effort in the face of the new information the Japanese provided. The need for political intervention had become increasingly evident. Most DoD officials agreed with the U.S. reporter who characterized the JDA as having "all but dismissed" the U.S. contractor proposals (Lachica, 1987a). The Japanese had made two fundamental points clear: (1) None of the U.S. contractor proposals fully met the FS-X operational requirements as first revealed in the October briefings, and (2) Japanese technology and subsystem development for an indigenous fighter were in advanced stages of development and could not be dropped or discarded. For the immediate future, the U.S. side believed it was now confronted with two basic options: either focus on further delaying the final Japanese source selection decision beyond the currently planned December deadline, or push for a broad agreement in principle now on a collaborative modification program and work to influence the content and details of such a collaboration later (Button, 1989b, p. 9).

The Americans chose the first option. The U.S. contractors insisted they needed time to reconfigure their modification proposals

⁴Interview with a senior U.S. industry official, August 4, 1992.

in light of the more detailed information presented on Japanese FS-X requirements. They also needed more time to find out about the Japanese avionics programs revealed at the briefings and how they might affect their modification proposals. GD was particularly hard-pressed because of the revelation that two engines was a critical requirement. During the visit to Tokyo, GD officials had actually put together a design concept for a two-engine F-16 literally overnight that was based on earlier conceptual studies faxed over from Ft. Worth, and they had briefed it to the Japanese. But the earlier design work had been minimal, and company engineers clearly needed additional time to flesh out a serious design proposal. More important, GD executives, as well as some government officials, felt uneasy about offering a two-engine F-16 concept, because it represented such a comprehensive modification that the final result would amount essentially to a new aircraft.⁵ McDonnell-Douglas officials also desired more time to respond to the new information on FS-X requirements.

As a result, both U.S. prime contractors formally requested that the Japanese delay the final selection and promised to provide reworked design proposals after January 1. In November, senior McDonnell-Douglas officials met with Senator John Danforth of Missouri,⁶ Chairman of the Subcommittee on International Trade, to update Congress on the FS-X negotiations and discuss political strategies.

The political leadership in the JDA soon responded to the U.S. pressure. The JDA Internal Bureau intervened with the ASO to push back the December deadline. More important, it decided to request a new series of meetings with DoD officials to explain Japanese objectives more fully in an attempt to reach a consensus with the Americans on an indigenous FS-X. The Internal Bureau increasingly recognized that, without such consultations, the FS-X issue could potentially grow into a major political dispute, with Congress linking it to trade frictions (Kohno, 1989, pp. 463-464).

A senior Japanese delegation led by Director General Tsutsui comprising representatives from the Air Staff FS-X Program Office and TRDI technical experts traveled to Washington in December to

⁵Interview with a senior U.S. industry official, August 4, 1992.

⁶Both McDonnell-Douglas and GD headquarters were located in St. Louis at the time.

provide more details on their domestic fighter development project to a broad spectrum of DoD and service procurement experts. This was the first comprehensive presentation by the Japanese to DoD technical personnel on the R&D plan for the indigenous FS-X and the advanced technology applications intended for the program. The visitors discussed the development of an all-composite cocured integral wing box and provided some more information on the domestic R&D efforts on APA radar and other advanced avionics.

DoD Criticizes Japanese Assumptions on Technology and R&D Costs

The presentations did indeed result in a consensus among U.S. officials, but it was not the one the Japanese desired. The American experts criticized numerous aspects of the R&D plan, including the analytical methodologies employed, the cost estimates, and the planned technology applications. U.S. experts argued that the Japanese calculations of technological risk and R&D costs were seriously flawed and dramatically understated by a factor of two or three. A primary reason for the U.S. reaction was the apparent sophistication and complexity of the composite-material applications and advanced integrated avionics planned for the FS-X, as revealed for the first time by the Japanese briefers. As the U.S. experts knew, these were cutting-edge high-risk technological developments far beyond anything on existing U.S. fighters or included in the modification design proposals offered by GD or McDonnell-Douglas.⁷ The U.S. audience also insisted that the operational mission analysis employed by the Japanese was too rigid and narrow, resulting paradoxically in FS-X operational requirements that were both unrealistic and unnecessary (Button, 1989a, pp. 16-17).

At the conclusion of the Tsutsui visit, it was obvious to all involved that the two sides had reached an impasse at the working level of technical experts. The Japanese representatives appeared more determined than ever to proceed with indigenous develop-

⁷The standard F-16 and F-18, of course, have conventional metal wing boxes. The wings of GD's SX-1 proposal were composed of composite skins over metal substructures. The other U.S. contractor proposals offered wing boxes with high-composite material content but that were not envisioned to be single cocured structures. All the U.S. proposals included conventional mechanically scanned fire-control radars and versions of other existing U.S. avionics.

ment. Their arguments centered around two issues: the alleged inability of the U.S. design proposals to meet ASDF operational requirements adequately and the need to apply the advanced domestic technologies and subsystems Japanese industry already had under development to the FS-X to make it a more competitive fighter for the late 1990s and beyond. On the American side, however, the briefings had solidified the working-level consensus against indigenous development. U.S. government and industry experts found the Japanese operational, technical, and cost assessments deficient. The American technical experts were particularly skeptical about the ability of Japanese industry to apply the advanced cocured composites and cutting-edge avionics technologies in an operationally effective manner and at an acceptable cost. The Americans agreed that the Japanese were grossly underestimating the technical difficulty and cost of developing a domestic fighter based on such advanced technology.

The analogies with the ongoing dispute with the Israelis over the Lavi were unmistakable to the American side. Throughout 1986, Pentagon technical experts had been involved in an increasingly acrimonious debate with the Israelis over what the Americans considered were overly optimistic assessments of development cost and technological risk. DoD independently evaluated projected Lavi R&D costs, resulting in much higher estimates, and demanded the Israelis participate in a full-scale joint evaluation of the Lavi's costs and operational capabilities compared to existing U.S. fighters (Perras, 1989).

Although they proceeded with much greater circumspection with the Japanese, DoD officials essentially began pursuing the same approach with the FS-X. At the end of the Tsutsui visit, the U.S. side proposed the establishment of a joint executive group to conduct a detailed study of the comparative effectiveness and cost of the American entries and the Japanese fighter. While skeptical about Japanese claims of advanced fighter technology development, Pentagon officials requested more information and greater access to permit a more extensive assessment. DoD suggested a visit to Japan by U.S. experts to take a closer look at these R&D efforts. DoD representatives also added a new American fighter candidate for Japanese consideration: the McDonnell-Douglas F-15E Strike Eagle. The F-15E, selected over the GD F-16XL in

early 1984 to become the Air Force's next long-range attack fighter, first flew the same month of the Tsutsui visit (Young, 1990).

DoD officials believed this extensively modified two-seat version of the F-15C interceptor optimized for the ground-attack mission would easily meet or surpass all the FS-X operational requirements. Since Japanese industry already license-produced the standard F-15C, selection of the F-15E would minimize program start-up costs. This suggestion also represented renewed pressure on the Japanese to move away from further indigenous technology development: Since the F-15E was already essentially developed, Japanese participation would be limited primarily to licensed production or coproduction (Button, 1989a, p. 17).

The Tsutsui delegation opposed addition of the F-15E to the American list of candidate fighters and rejected the proposed joint evaluation of the domestic FS-X. Tsutsui remained open, however, to a joint assessment of the U.S. candidates and a possible visit to Japan by a DoD team of technology experts. He also agreed to receive more contractor data on the U.S. derivative fighters in Japan sometime in March (Button, 1989a, p. 17).

Preparing for the Final Showdown: Linking Trade and Security Issues

In the early months of 1987, both sides began mustering their forces for the final showdown. On the working level in the Pentagon, technical experts pressed forward with the arguments and suggestions raised during the Tsutsui visit. The Office of the Joint Chiefs of Staff independently evaluated the Japanese threat scenario and mission requirements for the domestic FS-X. DoD worked closely with the services and the prime contractors to develop an effectiveness analysis of the original F-16 and F-18 modification proposals. Arrangements were made for a third visit by the contractors to Tokyo in late March and early April to present newly refined design options. Analysts conducted an initial assessment of F-15E performance, which showed that it met or surpassed all FS-X operational requirements, and DoD began formulating the details of a possible licensed-production proposal. The Pentagon pressed JDA to set up a DoD visit to Japanese indus-

try in early spring to examine indigenous technology programs (Button, 1989a, pp. 17-18).

Perhaps more important, senior Pentagon officials discarded their earlier strategy of trying to keep trade and security issues separate and began referring increasingly to congressional pressure and the risk of politicization of the FS-X issue in their dealings with the Japanese. This change became evident in January during a side meeting devoted to the FS-X between senior DoD and JDA officials at the annual U.S.-Japan security conference held in Honolulu. Assistant Secretary of Defense Armitage emphasized to Vice Minister Yazaki and Director Nishihiro of the JDA Policy Bureau that the mood of Congress had changed for the worse with the capture of both houses by the Democrats during the midterm elections in November. Armitage explicitly warned his Japanese colleagues that some congressmen intended to link security issues directly to the ballooning trade deficit (Kohno, 1989, p. 464).

The Japanese officials confirmed that the FS-X choice had been narrowed to either a modification of the F-16 or F-18, or domestic development. They expressed a willingness to examine the F-15E but only if both of the first two options proved unacceptable. They also rejected the Pentagon suggestion for a joint evaluation of all the candidate fighters as proposed during the Tsutsui visit. Armitage stressed that the United States would have difficulty supporting a decision for indigenous development. Nevertheless, at this point, the Assistant Secretary apparently offered for the first time a key concession to the Japanese: The United States would accept a collaborative modification program of a U.S. fighter with a Japanese company as the *prime contractor* (Button, 1989b, p. 13). This concession later opened the door for the emerging Japanese strategy of acquiescing to political pressure for collaboration but injecting the maximum Japanese technology and indigenous development possible into the resulting program.

In response to this series of meetings in late 1986 and early 1987, Japanese industry launched a final counteroffensive in February to save the domestic FS-X. At that time, the five leading military aerospace contractors—Mitsubishi, Kawasaki, Fuji, MELCO, and IHI—formed the Joint FS-X Study Group (*FSX Minkan Godo Kenkyukai*) to coordinate and refine the final domestic development proposal for JDA. The study group's initial presentation to JDA in March emphasized the superior Japanese

technology planned for application on the domestic FS-X. The study group also stressed their claim that a domestic fighter would cost considerably less than a collaboration program, in complete opposition to American expert opinion. They repeated the same unit-production cost estimate used in the original mid-1985 TRDI study of ¥5 to 6 billion (excluding R&D costs), or only about half of the current cost of license-producing the F-15J.

Despite this strong industry defense of indigenous development, U.S. officials detected around this time a distinct shift in leadership on the FS-X program that appeared to favor U.S. interests. The senior political levels of the JDA's Internal Bureau seemed to be taking full control of the FS-X program, relegating the ASO to a technical advisory role. This shift in direct control to the JDA political leadership was undoubtedly a response to increasing American political pressure (Kohno, 1989, p. 465; Button, 1989a, p. 18).

Indeed, in March, right before the scheduled contractor visits to Tokyo, the U.S. companies mobilized their heavy political guns against the Japanese. Led by Senator Danforth, Congress increased pressure on the Reagan administration to press for an American-based FS-X. Senator Danforth wrote letters to the President, Secretary Weinberger, and Secretary of State Schultz warning that the adverse reaction to a decision in favor of indigenous development could damage U.S.-Japan relations. He argued that purchase of a U.S. fighter was necessary to help reduce the trade deficit and predicted a resurgence of protectionist sentiment in Congress if the Japanese persisted with their domestic program. As he told reporters in midmonth (Lachica, 1987a),

There's no excuse for Japan producing the airplane all by itself, not with a \$60 billion trade surplus over the U.S. . . . This is one time the Japanese can't tell us that our products aren't good enough, or that they don't need what we make.

Danforth also echoed the views widely held in U.S. government and industry circles that the Japanese had grossly underestimated the cost and risk of the advanced technologies planned for application to the FS-X, predicting development costs two and half times greater than those projected by Japanese industry. The Japanese

stood by their cost estimates but clearly felt the political heat rising. The JDA soon offered one small concession by agreeing to receive a DoD delegation to examine Japanese FS-X technology developments in April (Noble, n.d.; Kohno, 1989, p. 465).

Updated Design Proposals to Meet Japanese Technology Requirements

The U.S. prime contractors presented their updated design proposals to JDA, TRDI, and ASO officials in the first two weeks of April, during their second major trip to Tokyo. The American companies had clearly gotten the message from the October briefings and the Tsutsui team visit in December that JDA and Japanese industry were very unlikely to support a minimally modified version of an existing fighter design. This time, the U.S. firms offered a wider variety of significantly modified designs. Apparently, the McDonnell-Douglas team now felt it had the inside track on the competition following the strong Japanese emphasis on the two-engine requirement during the October briefings and the resulting near withdrawal of the GD team from the competition at that time (Button, 1989b, p. 14). To reinforce its perceived advantage, the McDonnell-Douglas team presented three extensively modified F-18 variants intended to demonstrate more responsiveness to ASDF operational requirements and Japanese industry's wish for specific technology applications, as shown in Figures 6.1, 6.2, and 6.3. All had new wings and a lengthened fuselage. Two had maneuvering canards. More information was provided on the extensively modified Super Hornet Plus configuration, which specifically addressed Japanese industry's interest in applying advanced CCV technology, as expressed in October. McDonnell-Douglas briefers showed additional details on the radically redesigned "cranked-arrow" wing, canard, extended fuselage, and redesigned engine air inlets (Button, 1989a, Appendix B, pp. 42J-42L).⁸

⁸McDonnell-Douglas engineers had been studying novel maneuvering modes and configurations since at least the early 1970s with their "Vectored Lift Fighter" and Advanced Fighter Technology Integration F-15 design studies, as well as joint studies conducted with the Germans in the early 1980s. Interview, James Sinnett, Vice President, General Manager, New Aircraft Products Division, McDonnell Douglas, November 6, 1991.

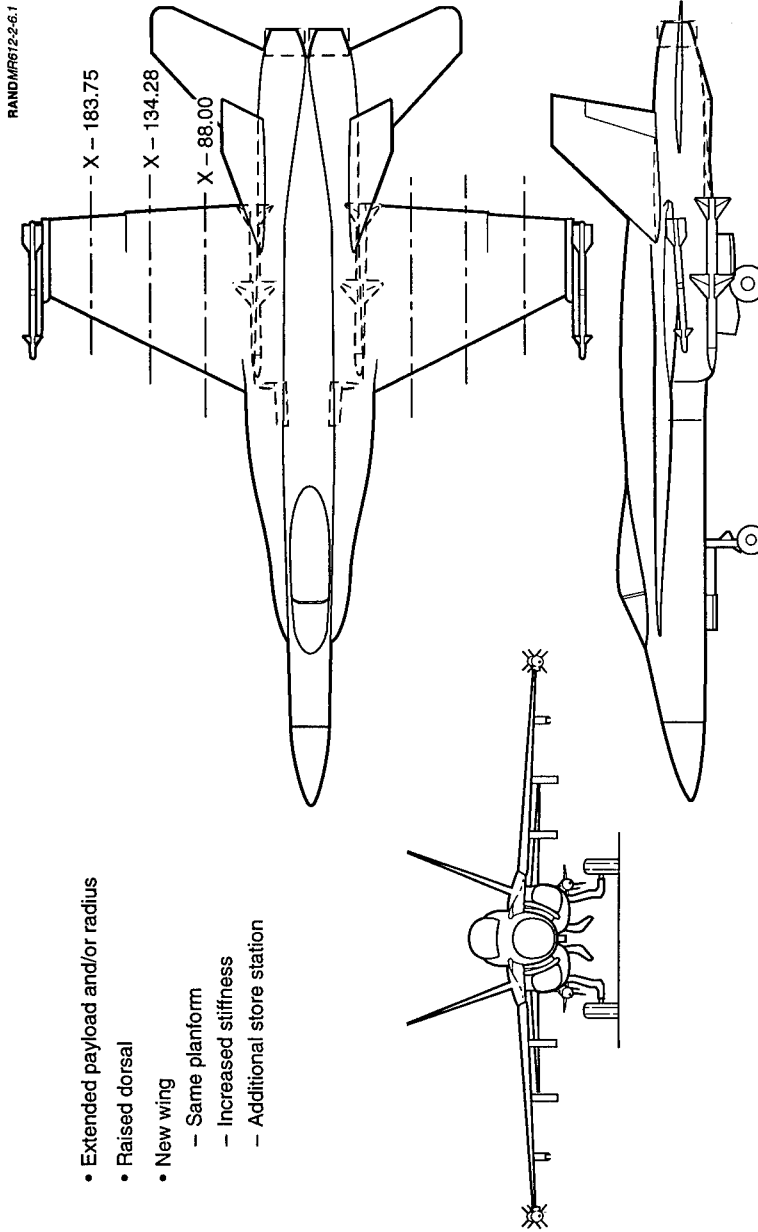


Figure 6.1—McDonnell-Douglas's Minimum Modification Proposal, April 1987

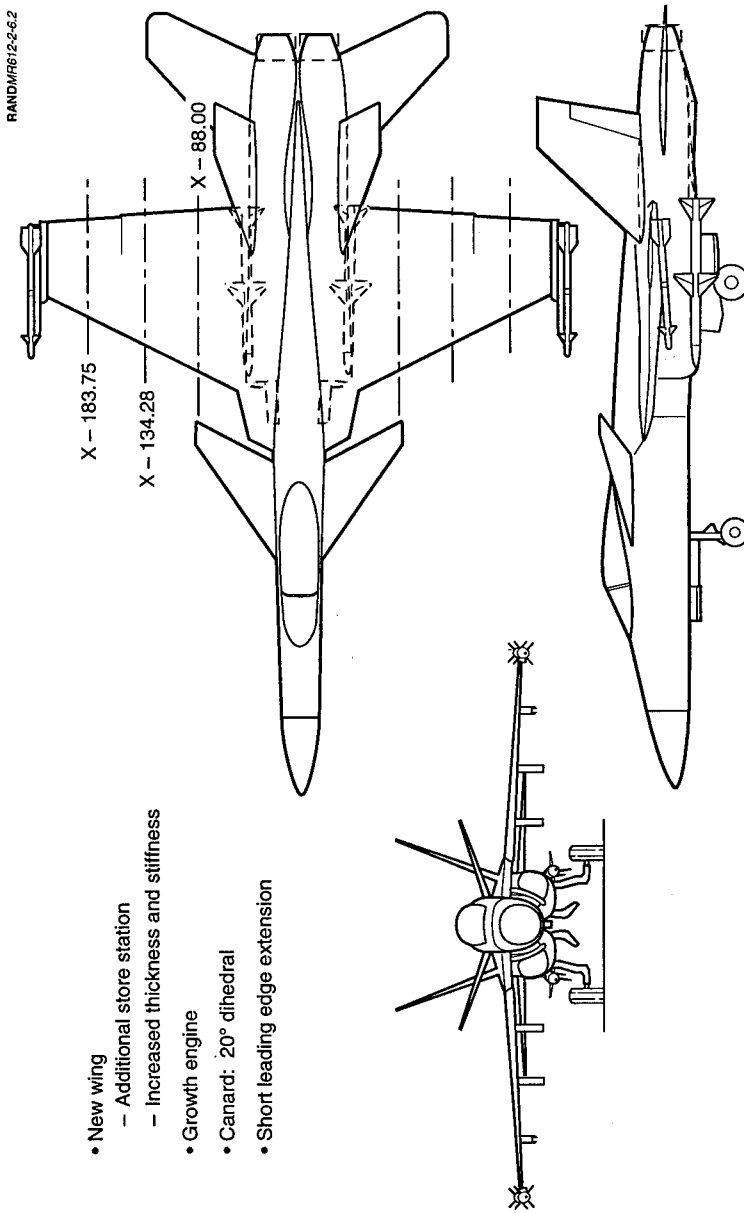


Figure 6.2—McDonnell-Douglas's Medium Modification Proposal, April 1987

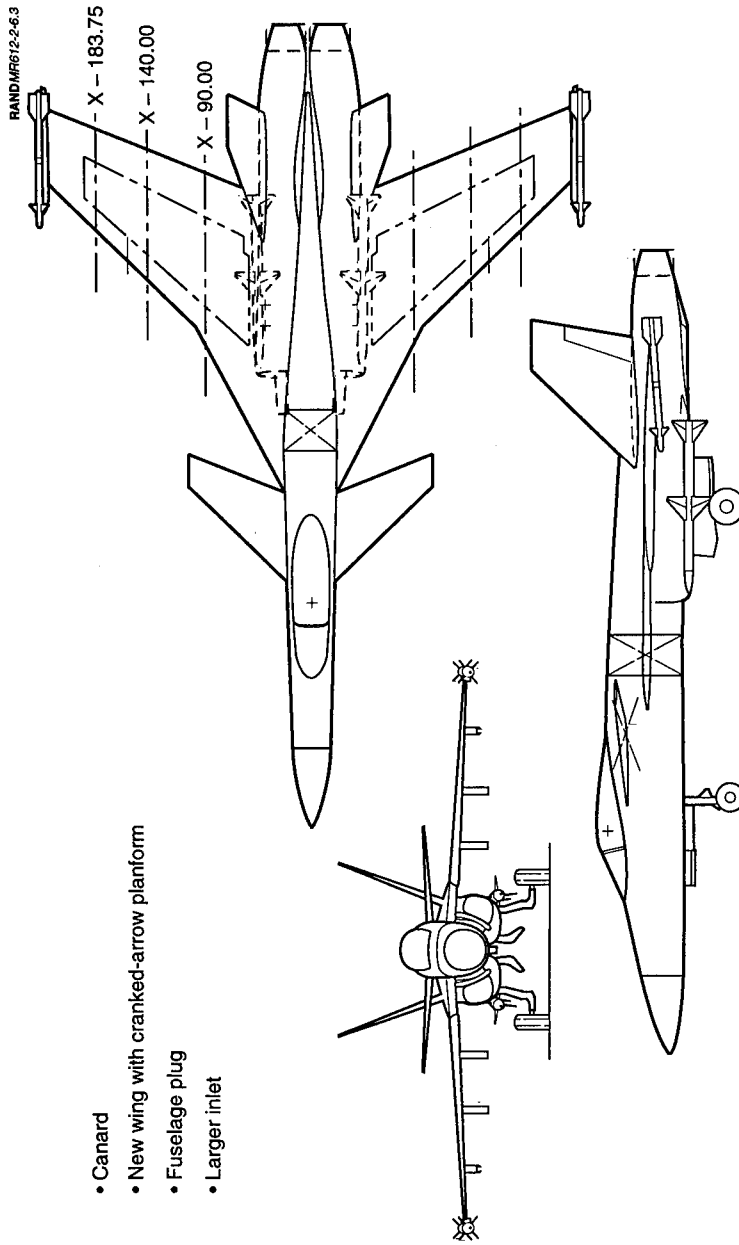


Figure 6.3—McDonnell-Douglas's Maximum Modification Proposal, April 1987

McDonnell-Douglas's new proposals clearly offered Japanese industry a greater variety of modification options that included significant additional R&D work and the potential to develop technologies of interest than presented in October. Nonetheless, the most radical modification (Figure 6.3) remained essentially the Super Hornet Plus configuration, which was being developed for possible U.S. Navy and European consideration. Except for a fuselage extension plug and a changed engine air inlet, the Super Hornet Plus fuselage remained the same as that of the standard F-18.

GD officials now perceived themselves at a distinct disadvantage because of the two-engine issue. Nonetheless, GD again presented its single-engine SX-1, SX-2, and SX-3 designs. The only significant addition was the company's new SX-4 proposal, GD's more formal response to the Japanese revelation of the two-engine requirement at the October briefings, as shown in Figure 6.4. With its different engines (GE F404s), longer and wider fuselage, and differently shaped and larger wings, vertical tail, and horizontal stabilizers, the SX-4 varied in every dimension and shape from the basic F-16 and the other GD modification proposals.

Engineers had based the SX-4 on an earlier company study of two-engine versions of the F-16. Company management had originally terminated this study in late March 1986 because analysis showed that this modified fighter would not perform significantly better than the existing F-18. More importantly, the modifications required were so extensive that the resulting development work and cost would approximate that of an entirely new aircraft. In short, GD saw no commercial or technological advantage at the time to reinventing the F-18 at great additional cost.⁹

However, this was not the case for the Japanese. Although the Japanese remained noncommittal at the conclusion of the April industry briefings in Tokyo, U.S. political pressure for collaboration was becoming irresistible. Proposals like the SX-4 and the CCV Super Hornet Plus offered Japanese industry and the government supporters of *kokusanka* their best opportunity to preserve their domestic fighter technology and design development objectives if forced into a cooperative program based on a U.S. fighter.

⁹Interview with a senior U.S. industry official, August 4, 1992; Button (1989a), Appendix B, pp. 42G-42I.

RANDMR6122-6.4

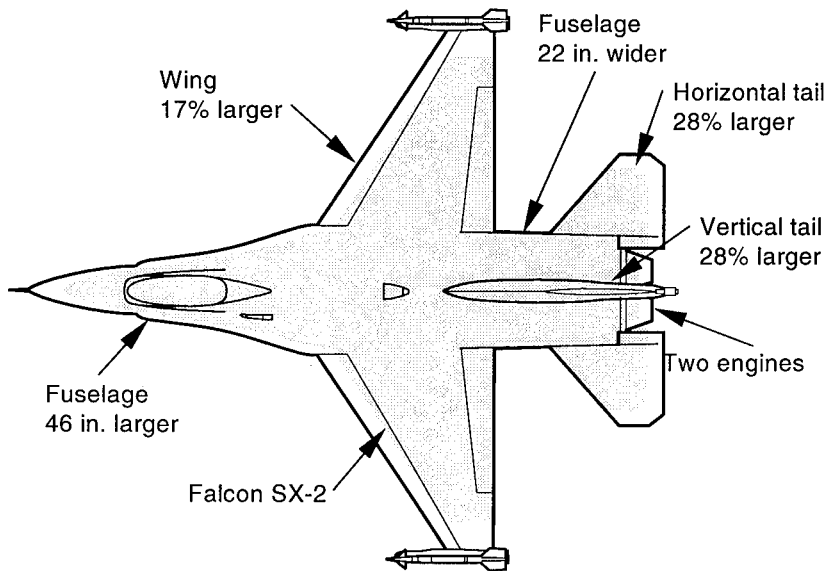


Figure 6.4—GD's SX-4 and SX-2 Proposals Compared, April 1987

For all practical purposes, collaboration on one of these proposals approximated joint development of a virtually new fighter. These designs represented a tremendous opportunity for extensive Japanese design and development work and the application of new technologies. Only three months earlier at the Honolulu security conference, Assistant Secretary of Defense Armitage had officially expressed America's willingness to accept a Japanese company as prime contractor. It was not unreasonable to assume that a Japanese prime contractor could exercise considerable influence over the specific content and shape of the actual development program. Furthermore, no formal discussions had yet taken place on which companies would take the development lead on which technologies or parts of a jointly developed aircraft. The Japanese had made it increasingly clear since the October briefings that they had numerous technology and R&D programs under way for their domestic fighter that they were not willing to discard. Indeed, McDonnell-Douglas had clearly reconfigured its presentation of the Super Hornet Plus proposal for the March briefings to emphasize

CCV technology because of the strong interest expressed by Japanese industry in this area. Although hope of saving the domestic fighter still remained alive, Japanese industry increasingly saw the potential for salvaging many of its technology and design objectives if forced into a cooperative program based on radically modified U.S. designs, such as the SX-4 and the CCV Super Hornet Plus.

Pentagon officials, however, viewed the U.S. contractor proposals quite differently. It was widely assumed that the U.S. side would retain overall control of any joint R&D effort, including fighter configuration, technology applications, system integration, and technology transfer to the Japanese. A primary reason for this view was the conviction that Japanese industry did not have anything approaching the experience and capabilities of the U.S. contractors in overall fighter R&D and military subsystem development, especially given the cutting-edge technologies the Japanese wished to incorporate into the domestic FS-X. Indeed, the more dramatic the modification proposal, it was thought, the greater the practical need for the U.S. companies to provide the overall technology leadership and control of the R&D program. In certain respects, the planned Pentagon trip to Japanese industry in April was perceived as an opportunity to call the Japanese "bluff" on their persistent but still rather vague assertions of superior domestic technology developments as a justification for an indigenous fighter. In addition, many DoD officials had come to believe that the Japanese FS-X program was dominated by industry and the working-level engineers at TRDI and the ASO who were pushing advanced technology development at the expense of broader Japanese military, strategic, and alliance interests. Thus, a central purpose of the April Pentagon visit was to go over the heads of the technical experts and engineers who predominated at the U.S. contractor briefings and on the Tsutsui delegation visit and present the American technical case against the domestic FS-X directly to the highest political levels of the JDA.¹⁰

¹⁰Interview, Gerald Sullivan, conducted by Arthur Alexander of RAND, August 1989.

The Sullivan Visit: Discounting Japanese Fighter Technology

Led by Gerald Sullivan, Deputy Assistant Under Secretary of Defense for International Programs and Technology, the Pentagon team arrived in Tokyo on April 11 immediately following the U.S. industry briefings. The visit was divided into two parts. In the first segment, the team presented a series of briefings and held discussions with senior JDA and ASDF officials on DoD mission scenario analyses and on cost and technological risk estimates for fighter development. The central Pentagon message was a much more well-documented version of the critique presented to the Tsutsui delegation in December: The Japanese assessments of operational requirements, R&D cost, and technological risk were profoundly flawed. The DoD briefers pressed home the argument that, given the cutting-edge technology applications planned for the domestic fighter and the lack of Japanese industry experience in complex military R&D, the indigenous FS-X would cost two to three times more and take far longer to develop than claimed by Japanese technical experts. The senior JDA officials appeared noncommittal; the technical representatives from the ASO and TRDI, however, clearly expressed continued commitment to indigenous development.¹¹

Following these briefings, the Sullivan team spent the next several days visiting key Japanese industry sites to take a first-hand look at the Japanese military technology programs and to assess industrial capabilities to develop an indigenous fighter (Button, 1989a, p. 21). In one sense, these visits could be seen as a dramatic breakthrough for the American side. They represented the first time U.S. government officials were given the opportunity to view a broad array of technology developments under way for the domestic FS-X. The only other time U.S. government officials had seen any of these developments in an official capacity was when Japanese officials provided a brief glimpse of the APA radar development program to the DoD TAT in July 1984. In follow-up visits, TAT members had tried to acquire more details about the

¹¹Interview, Gerald Sullivan, conducted by Arthur Alexander of RAND, August 1989; Button (1989a), pp. 19-20.

MELCO radar program, but had been denied any further access or information.

Yet even on this trip, the Americans experienced difficulty gaining full access to Japanese R&D projects of interest. The U.S. team had originally requested to visit the facilities of all the industry members of the FS-X Study Group, but the Japanese limited the on-site inspections to Mitsubishi's facilities at Nagoya, where the single-piece cocured composite wing box for the FS-X was under development, and to MELCO's plant at Kamakura, where work was progressing on components for the APA fire-control radar and other advanced avionics. Some team members also visited the ASDF flight test center at Gifu to observe the Mitsubishi T-2 CCV FBW technology demonstrator.¹²

Not surprisingly, the U.S. team was particularly interested in learning more about MELCO's APA radar and MHI's large cocured composite wings. However, the Japanese refused once again to permit the U.S. visitors even to view the prototype radar, although they toured the flight-test facility. The Americans then requested test and evaluation data on the radar, but their hosts also declined to provide this information. Japanese officials did show their visitors examples of the GaAs MMIC-based T/R modules for the APA radar antenna and some of their other advanced avionics components, such as flat-panel displays mounted in a fighter cockpit mock-up. At MHI, the U.S. team saw a test wing-box structure for development of the cocured composite FS-X wing. However, Japanese officials again refused to provide any information on production methods and tooling or on design and test data.¹³

Based on these firsthand but limited observations, the U.S. team concluded the Japanese had some interesting projects and innovative technologies under development but remained far behind the United States in overall system development and integration. Team members were impressed with the engineering of some of the components, such as the T/R modules and flat-panel displays. However, they saw no evidence of sophisticated systems or subsystems in an advanced stage of development. They had seen

¹²However, the Japanese authorities permitted the U.S. team to meet with representatives of the other major firms involved with FS-X at MHI Nagoya. (Button, 1989a, pp. 19-20.)

¹³GAO (1990), pp. 28-29, 32; interview with Gerald Sullivan, August 1989.

no radar or antenna array. Furthermore, it appeared that little work had been done on tactical modeling of the radar design, processing algorithms, and software development. While the flat-panel displays were impressive, the fighter cockpit mock-up in which they were mounted seemed rudimentary by U.S. standards. The cocured composite specimen viewed at MHI indicated the use of sophisticated bonding technology, but the specimen was far from being a usable fighter wing. It was not shaped into the complex curves of a genuine airfoil and did not have the complicated internal "plumbing" and fuel storage areas necessary in a real wing.¹⁴

It is important to emphasize here that, unlike the earlier DoD TATs that had visited Japanese electronics firms in 1984, 1985, and 1986, the Sullivan delegation had not been tasked to assess specific Japanese technologies for possible application to U.S. defense programs. Instead, its primary objective was to gain a sense of how far Japanese companies had progressed in developing and applying their advanced technologies for use in an indigenous fighter R&D program. With this fundamentally different objective in mind, it is not difficult to understand why the Sullivan team came away more convinced than before that the Pentagon's critique of Japanese indigenous development remained valid. Based on decades of U.S. experience with complex military R&D programs, team members believed that, no matter how innovative or interesting some of the Japanese technology programs might be, the government would have to spend vast additional sums of money and time to further develop, refine, and integrate these technologies into an operationally effective fighter. They strongly doubted that the resulting national fighter would be as effective as current U.S. fighters, but they were certain it would cost immensely more. Therefore, they firmly believed that indigenous development was not in the best security interests of Japan or the ASDF. They suspected that the domestic FS-X was driven primarily by the technology programs controlled by the technocrats and engineers at TRDI and ASO and in industry, not the objective security interests of the nation. Prior to leaving Tokyo, the Sullivan team extensively briefed the senior levels of the JDA on these impressions

¹⁴GAO (1990), p. 32; interview with Gerald Sullivan, August 1989.

from their visit in the hopes that they would intervene against the working-level technologists.¹⁵

It is not certain what effect these arguments had on the senior JDA leadership. It is clear, however, that industry and other *kokusanka* supporters remained steadfast in their support of indigenous development and the alleged superiority and lower cost of Japanese technology applications for the Rising Sun fighter. Nonetheless, throughout the spring, opposition to the American demands for collaboration rapidly began to crumble on the highest political levels. This collapse of resistance appears to have been caused not by any technical critiques provided by the Pentagon to the JDA leadership, but primarily by a significant deterioration in U.S.-Japan relations driven by festering trade disputes and by the resulting pressure from Congress on the Japanese government to buy American defense products.

The inevitability of some form of collaboration with the United States on the FS-X because of this political pressure became increasingly clear to the supporters of *kokusanka* throughout the spring. Yet the precise nature and content of that collaboration remained undetermined. The overriding U.S. objective appeared to be to stop indigenous development and replace it with a collaborative program based on a U.S. fighter. But the American side seemed much less certain, and potentially more flexible, on the definition of the details of such a program.

As a political decision in favor of collaboration appeared more likely, the strategy of the *kokusanka* supporters shifted increasingly from fighting a rearguard battle for genuine domestic development to achieving the application of the maximum design and technological objectives on a collaborative program that had been originally intended for an indigenous FS-X. The optimal compromise solution from their perspective would have been cooperative development of an entirely new jointly designed fighter with a Japanese firm as the prime contractor. Such a compromise, if carefully crafted, would have permitted the realization of most of the national technology objectives slated for a domestic fighter and would have included the additional benefit of possible access to American technology and expertise. Barring this solution, cooperation on one of the radical modifications the U.S. contractors pro-

¹⁵Interview with Gerald Sullivan, August 1989; Button (1989a), p. 21.

posed, such as the Super Hornet Plus or the SX-4, could serve most of the same purposes if the details of the program were carefully structured. Either way, the *kokusanka* supporters sought to preserve the Rising Sun fighter under the guise of a collaborative program, given the increasingly likely capitulation of the political leadership to American pressure to stop an indigenous program.

TRADE FRICTIONS AND THE TOSHIBA INCIDENT DOOM AN INDIGENOUS FS-X

A dramatic escalation in trade tensions between the United States and Japan in the spring of 1987 and the resulting clear linkage of economic and security issues by Congress sealed the fate of a wholly indigenous FS-X. On April 17, less than a week after the arrival of the Sullivan team in Tokyo, the U.S. government imposed severe trade sanctions against Japanese electronics products in retaliation for alleged dumping of microchips on the U.S. market. The Japanese government immediately dispatched a special envoy to ease trade frictions. In meetings with the Senate leadership, the Japanese envoy was reportedly counseled that "the decision to purchase your new aircraft from the U. S. would be taken, in particular, as a sign of good will by Japan and as a tangible guarantee of a continuation of our close security relationship."¹⁶ At the end of the month, the House of Representatives passed two separate bills, generally interpreted as aimed largely at Japan, that mandated stiff penalties against trading partners whose practices were deemed unfair. Trade tensions dominated the discussions between Prime Minister Nakasone and the Reagan administration during the Japanese leader's visit to Washington in late April. During these meetings, Secretary Weinberger explicitly asked the Prime Minister to approve purchase of a U.S. fighter, as did Senator Danforth and other members of Congress. During the meetings, Weinberger requested a special meeting with Director General Kurihara in Tokyo in June that was widely viewed by the Japanese as aimed at settling the FS-X issue once and for all on American terms at the highest political levels (Kohno, 1989, pp. 466-467; Noble, n.d., pp. 15-16).

¹⁶Quoted in Kohno (1989), p. 466.

Finally, and possibly most important, a major scandal involving the export of Japanese dual-use high technology to the Soviet Union blew up in May, causing considerable outrage in Congress and among the American public. At that time, it was revealed that the Toshiba Machine Company had secretly exported sophisticated computerized milling equipment through KGB agents that could be used by the Soviets to manufacture submarine propeller blades that would render their strategic nuclear ballistic missile submarines far more difficult to detect and track by U.S. military forces. U.S. anger over the "Toshiba incident" had an immediate and deleterious effect on U.S.-Japan relations. The U.S. Army withdrew its request for Toshiba's seeker-head technology, used on the Keiko SAM, scuttling the one program that, after years of tortuous negotiations, had been intended to set a precedent for the transfer of defense-related technology from Japan. DoD also banned all military contracts to Toshiba. Both houses of Congress introduced legislation to prohibit the importation of Toshiba consumer products to the United States. More than any other event, the Toshiba incident explicitly linked trade disputes and security issues in a way that neither DoD nor the senior Japanese political leadership could ignore (Kohno, 1989, p. 468; Noble, n.d., pp. 16-17).

Faced with this onslaught of American criticism and political pressure that directly linked FS-X to trade frictions, the *kokusanka* supporters recognized that independent domestic development was no longer politically feasible. The industry Joint FS-X Study Group shifted its focus toward collaborative development of an all-new fighter under Japanese leadership as the next best option (M. Green, 1990, p. 44). This position was pressed by the JDA's Seiki Nishihiro in discussions with Assistant Secretary of Defense Armitage during a visit to Washington in June to update Pentagon officials on the findings of the FS-X study group. Armitage expressed DoD's firm opposition to cooperative development of a new design, basing his arguments on earlier Pentagon analyses and the Sullivan team's conclusions that such an effort would be too costly. He recommended adopting McDonnell-Douglas's F-15 as the baseline aircraft, as first suggested during the Tsutsui visit in December. Armitage also raised the stakes by warning that a failure to follow U.S. leadership on the FS-X decision would mark a funda-

mental reordering of the U.S.-Japan alliance (Button, 1989b, p. 16). After extensive discussion, Nishihiro appeared to accept the arguments for jointly developing a modified version of an existing U.S. fighter. Among the mutual benefits of such a program discussed by the two officials was the two-way flow of defense technology (Chinworth, 1992, p. 145; Button, 1989a, pp. 21-22).

Secretary Weinberger strongly advanced the same arguments in meetings with Prime Minister Nakasone, Foreign Minister Kuranari, and Director General Kurihara during his visit to Tokyo in June. Weinberger dropped all pretense of arguing solely on the grounds of operational and cost effectiveness by referring to the angry mood of Congress and the severe damage to Western security interests caused by the Toshiba incident. Kurihara again urged U.S. acceptance of collaborative development of a wholly new design as an alternative to a modified U.S. fighter, but Weinberger strongly opposed it. The Director General countered that a final Japanese decision would have to await the outcome of ongoing JDA FS-X studies and would be based solely on the military requirements of the ASDF and Japan. However, the Japanese officials noted that the importance of the U.S.-Japan security relationship would also be an important consideration (Kohno, 1989, pp. 468-469; Noble, n.d., p. 17).

Although Kurihara had staved off acceptance of the U.S. position a little longer, it soon became evident to the *kokusanka* supporters that even their fall-back strategy of joint development of a new fighter was becoming politically impossible. The FS-X decision was becoming too thoroughly politicized in Congress and too closely linked to trade problems to risk continued opposition to the Pentagon's proposal for cooperative modification of a U.S. fighter. On June 30, the same day Weinberger met with Kurihara in Tokyo, the Senate passed its punitive measures against Toshiba by the overwhelming majority of 92 to 5. About two weeks later, the Senate *unanimously* approved a resolution sponsored by Senator Danforth and Senate Majority Leader Robert Byrd demanding that the Japanese purchase an American fighter for the FS-X. The increasingly vehement demands of Congress for direct Japanese purchase of an existing U.S. fighter made DoD's offer appear more attractive. To prevent a further deterioration in the U.S.-Japan relationship,

Prime Minister Nakasone publicly indicated in early August that Japan was likely to accede to American requests on the FS-X.¹⁷

With the political leadership clearly acquiescing to U.S. pressure, the only remaining viable strategy for the *kokusanka* supporters was to influence the selection of the baseline U.S. fighter and the actual structure and technological content of the joint modification program to preserve as many of their original domestic development objectives as possible. The most desirable U.S. modification proposal from this perspective would be the one that entailed the greatest additional design and development work. But even more important for the *kokusanka* supporters would be the attainment of Japanese industry R&D program leadership and maximum application of Japanese technology and subsystems.

Japan Moves to Preserve Technology Objectives on a Collaborative Program

The Japanese industry FS-X study group began focusing on this new strategy in its interactions with the American contractors following the meetings in Washington and Tokyo in June, during which Armitage and Weinberger had firmly rejected the Japanese suggestion of joint development of a new design. It appears that Japanese industry initially favored GD's two-engine SX-4 proposal because it came the closest to replicating the development of an entirely new fighter (Button, 1989a, p. 22). McDonnell-Douglas's Super Hornet Plus also was also viewed as a leading candidate because it required extensive modifications and incorporated technologies of interest to Japanese industry. However, the Super Hornet Plus fuselage remained largely unchanged in design from the existing F-18. Yet, while the SX-4 resembled the F-16, it actually required more modification from the baseline aircraft. In addition to its all-new wings and stabilizers, the SX-4 fuselage had to be completely redesigned and engineered to accommodate two engines. Every part of the airframe except the radome and

¹⁷Nakasone's stated reason at the time was that "We should place the highest priority on stabilized security ties with the U.S. when we think about the Toshiba case and the next fighters." Quoted in Kohno (1989), p. 469, footnote 26.

the cockpit canopy was significantly different from the existing F-16.¹⁸

Unbeknownst to the Americans, the Japanese had also begun looking at a totally new candidate: a standard F-15J as license-produced by Mitsubishi and modified by Japanese industry to incorporate the new subsystems and technology under development for the FS-X. MHI had conducted a study of this option in April and May without informing the U.S. contractors or the Pentagon (Button, 1989b, p. 18). The obvious advantage of this approach was that all the initial design work and modification objectives originated from Japanese industry, not American firms trying to please the U.S. services and other potential foreign customers, as well as the Japanese. Furthermore, Japanese industry would be in a strong position to demand program leadership during R&D.

Thus, by early summer 1987, it appeared almost certain that the Japanese would agree under duress to the Pentagon's proposal to modify jointly an existing U.S. fighter to fulfill the FS-X requirement. However, the selection of which fighter, and what modifications to make on it, remained open. The decisions on these issues would be crucial for both U.S. and Japanese objectives. Not surprisingly, the two sides still remained far apart. The *kokusanka* supporters favored the SX-4, the Super Hornet Plus, or the F-15J domestic modification, with Japanese program leadership and maximum application of indigenous subsystems and technology. Like their earlier offer of cooperative development of a new fighter, the Japanese concept of collaborative modification of a U.S. fighter remained close to indigenous development with assistance from U.S. contractors.¹⁹

U.S. industry and government officials were not oblivious to the strategy of the *kokusanka* supporters. Indeed, since the October 1986 industry briefings in Tokyo, many on the U.S. side had been particularly uncomfortable with the GD SX-4 proposal. GD officials had told Japanese industry representatives from the beginning that they were not really interested in developing a two-engine design, but the Japanese had kept pushing it. To the

¹⁸Interview with a senior U.S. industry official, August 4, 1992.

¹⁹See Chinworth (1992), p. 144; "Debate Over F-15 Derivative Clouds Selection of Japanese FS-X Fighter" (1987), pp. 178-180.

American contractor, it seemed wasteful and irrational to expend the additional money necessary to develop an essentially new fighter that would be roughly comparable to the F-18. Neither the Air Force nor the Navy was interested in such a fighter, and it would not likely be a cost-effective competitor against the F-18 on the world market because of the high development costs. GD studies showed that the SX-4 would offer no significant performance advantage over the existing F-18 to justify the additional development costs. From the GD perspective, the only plausible explanation for Japanese interest in the SX-4 was to advance the R&D objectives of Japanese industry. GD managers suspected that Japanese industry sought to exploit the American contractor's expertise primarily as a consultant while using the SX-4 concept as a vehicle for pursuing what amounted to indigenous development.²⁰

Many Pentagon officials shared these concerns, and felt they applied equally to the Super Hornet proposals. This is why DoD had apparently come to favor the F-15 by early summer as the baseline fighter. Either the new F-15E or the standard F-15C with some modifications could fully satisfy all Japanese operational requirements, including the preference for two engines. Production start-up costs and technology transfer concerns would be minimized because of MHI's ongoing licensed production of the standard F-15. Little modification or redesign of the basic airframe would be necessary.

DoD's New Offensive Against Foreign Fighter Programs

Primary DoD objectives for collaboration had always been reduction of wasteful and costly duplication of R&D among allies, greater standardization and interoperability of U.S. and allied equipment, and allied burden-sharing for the development of weapon systems required by the U.S. services. The SX-4 proposal served none of these interests. Japanese demands for project leadership, configuration control, and maximum application of indigenous subsystems and technology on all the other U.S. contractor proposals for major modification programs, such as the SX-2, SX-3,

²⁰Interview with a senior U.S. industry official, August 4, 1992.

and Super Hornet series, also undermined these objectives. It was hard enough to convince the U.S. services to accept the minimal compromises on requirements necessary to entice allies to participate in U.S. procurement programs. Genuine Japanese control of design and technology development on the FS-X would make this job even more difficult.

FS-X, however, was only one example of the much larger problem of proliferation of indigenous fighter programs among allies that threatened to undermine the Pentagon's quest for greater burden-sharing, R&D pooling, and equipment standardization. Along with FS-X, several other allied fighter programs were reaching critical decision stages or were seen as particularly vulnerable at this time. In August 1985, the United Kingdom, Germany, and Italy had finally agreed to proceed with the project definition stage for the EFA. In September, Spain joined the project, but France formally withdrew to pursue its own indigenous Rafale fighter. The continuation of these two programs meant the potential loss of the most important European markets for U.S. fighter contractors, and significant new competition in the global marketplace.

Both programs remained politically shaky, however, primarily because of their escalating costs. The Eurofighter consortium had planned to conclude the EFA definition stage in July 1986 and to commence full-scale development soon thereafter. However, mounting concerns about high program costs led to an extension of the definition phase. In September, the participants decided to delay the full-scale development decision to at least mid-1987, ordering their national industries and air forces to find ways to cut development costs. But by June 1987, the EFA partners had failed to reach a consensus on full-scale development and were becoming embroiled in a major dispute over the planned radar for the fighter that focused on issues of cost and technology. Opposition to EFA was dramatically increasing in Germany over the cost issue, and Spain's commitment to the program continued to waver (see Curtis, 1987; Mordoff, 1987; Latham, 1989).

Meanwhile, both the EFA consortium and the French continued unsuccessfully to seek additional partners to help spread the financial burden. The French targeted the Belgians and, along with the EFA program, sent out feelers to the Netherlands and Denmark, all operators of the F-16 and prime targets for GD marketing efforts. At the same time, the Swedes began escalating

their sales program for the Gripen fighter after roll-out of the first prototype in April. The Swedes particularly focused on Denmark, whose air force had purchased Swedish fighters in the past. Finally, the Israeli government defiantly forged ahead on the Lavi after the successful first flight of prototype number one on the last day of 1986, despite intense criticism at home and from the U.S. government. Yet neither the Europeans nor the Israelis were able to snag new commitments to buy their fighters or participate in development (Timmerman, 1987; Fink, 1987).

Consequently, in mid-1987, Pentagon officials recognized that a narrow window of opportunity had opened for a concerted attempt to kill or seriously undermine several of these "wasteful" allied indigenous programs all at once. The Pentagon hoped to put together one or two definitive modification configurations based on the F-16 and F-18 that could be effectively marketed as high-performance, lower-cost alternatives to the EFA, Rafale, Gripen, and Lavi, as well as to the indigenous FS-X. A central element in this strategy was to win official blessings from the U.S. services for specific modification configurations. Interest by the Air Force or Navy in procuring one of the modified models would increase its attractiveness to potential foreign customers. Foreign participation would advance the objectives of equipment interoperability and standardization with allies and dramatically reduce U.S. and allied procurement costs. Thus, on July 15, Secretary Weinberg issued a directive to the Air Force and Navy to "initiate separate studies of F-16 and F/A-18 derivatives that might be procured in the 1990s." His directive stressed the importance of containing costs by seeking international collaboration on these modification proposals. Therefore, he explicitly ordered the services to consider the military requirements of allies as potential procurement partners in their studies.²¹

Elimination of the SX-4 Proposal

It was within the context of this initiative that the Pentagon sought to reduce the number of design configurations offered to the Japanese and to standardize on one or two proposals that would be

²¹"Pentagon Initiative Triggers New Interest in Joint Ventures" (1987); "Improving U.S. Strike Fighters" (1987).

attractive to the U.S. services and other allies. In July, after close consultation with DoD officials, GD managers decided to withdraw the SX-4 proposal from the FS-X competition and to concentrate on the SX-2 and SX-3 proposals based on the Agile Falcon. GD management believed this action would probably lead to Japanese selection of the Super Hornet Plus or one of McDonnell-Douglas's other candidates. However, both the U.S. Air Force and the European operators of the F-16 (Belgium, the Netherlands, Denmark, and Norway) seemed seriously interested in the Agile Falcon proposal. Furthermore, the Israelis were clearly on the verge of caving in to the massive U.S. pressure to cancel the Lavi; as an incentive to do so, U.S. officials considered offering participation in further F-16 production or possible collaboration on the Agile Falcon program.²² GD also attempted to hold discussions with the Japanese FS-X firms, but they declined to meet with the U.S. contractor. In short, GD and the Pentagon saw no reason to help Japanese industry develop a virtually all-new fighter like the SX-4 just to win participation in a single-nation program for a relatively small number of aircraft, when U.S. Air Force, European, and possible Israeli interest in the less drastic Agile Falcon modification held out the prospect of a large-scale international collaboration program totaling many hundreds of fighters. As a result, late in the month, GD responded to the Weinberger directive by forwarding a formal proposal to the Pentagon for a collaborative program with European and possibly other allies based solely on the Agile Falcon design. The proposal projected initiation of full-scale development in 1990 and series production by 1995 (Button, 1989a, p. 22).

With the SX-4 out of the competition, most U.S. government and industry observers believed that the Japanese would select one of the Super Hornet proposals that offered extensive new design and development work. However, several considerations soon emerged that drastically decreased the attractiveness of these proposals to the Pentagon, U.S. industry, and the Japanese government. Following the Weinberger directive to the services in July, the Navy soon made it clear that it had no intention of contributing

²²Israel canceled the Lavi program on August 30, 1987 (see "General Dynamic's Proposed Agile Falcon Upgrade," 1987; "What Follows Israel's Lavi?" 1987).

funds for the kind of major airframe modifications called for in the Super Hornet proposals for the sake of the export market. Because of tight budgets, the fact that the F-18 was a more recently developed fighter than the F-16, and its hope to replace its F-14s eventually with a version of the ATF as its premier air-superiority fighter, the Navy had decided for the foreseeable future to reject any structural modifications whatsoever for its own upgraded F-18s. Rather, it called for a lower-cost, evolutionary upgrade program through the 1990s that entailed relatively modest improvements to the avionics and engine of the existing fighter. This decision was reinforced by the hostile reaction of the European EFA partners to the Super Hornet proposals²³ and the apparent interest in some circles within the United Kingdom and Germany in the possible purchase of standard F-18s with avionics improvements. Indeed, McDonnell-Douglas renamed its joint design study with the Navy, launched after the Weinberger directive, as the Hornet 2000, implying a much longer time horizon for a major F-18 modification program than envisioned by the Air Force for Agile Falcon. With little near-term U.S. Navy and questionable European interest in a program for radical modification of the F-18, the Super Hornet started taking on some of the same undesirable characteristics from the Pentagon perspective as the SX-4 proposal, with one major qualification. In the unlikely event that the Japanese were willing to pay for development of the Super Hornet, while accepting U.S. control over the requirements, configuration, and technology in the interest of possible future Navy procurement and as a continuing alternative to EFA, then it could possibly remain a viable candidate.²⁴

Thus, the push by DoD in July to impose greater discipline on the wide-ranging industry efforts for foreign sales and collaboration programs to achieve the cost benefits of standardization with U.S. allies suddenly confronted the Japanese with considerably reduced or more constrained options for cooperative modification of a

²³One Royal Air Force officer reportedly responded to McDonnell-Douglas's proposals, "Even a lousy EFA is better than any Super F/A-18." Quoted in Cook (1987b), p. 1133.

²⁴See "F/A-18 Upgrade: Don't Look for 'Agile Hornet'" (1987); "Navy Will Avoid Major Changes to Structure of F/A-18 Hornet" (1987). McDonnell-Douglas, of course, continued vigorously marketing the Super Hornet as an alternative to EFA in Europe. See "Super Hornet Plus Pushed in European Market" (1987).

U.S. fighter. The Japanese did not learn of the decision to withdraw the SX-4 design from the competition until August. In that month, a Japanese industry delegation representing the FS-X Joint Study Team visited both U.S. prime contractors for a more detailed assessment of their fighter modification proposals. The sessions at Fort Worth got off to a rocky start when GD officials informed the Japanese on the first day of their visit that the SX-4 had been withdrawn. After consultation with Tokyo, however, the visiting delegation continued on with the rest of the week's briefings and discussions (Button, 1989a, p. 24).

TRANSFORMING THE SX-3 TO SERVE JAPAN'S TECHNOLOGY OBJECTIVES

Although the meetings at GD went reasonably well, U.S. industry and government circles remained convinced that, with the SX-4 eliminated, the Japanese would choose a version of the Super Hornet. Unknown to most of the U.S. participants, however, officials in the MOF, JDA, and elsewhere in the Japanese government were becoming increasingly concerned about the relatively high projected cost of the McDonnell-Douglas entry. A central problem driving up Super Hornet cost projections stemmed from the general lack of immediate U.S. Navy or European interest in the modification proposal. The engine stood out as the most important issue. The Super Hornet variants of interest to the Japanese required developing either totally new engines or significantly improved versions of the existing F-18 General Electric F404 engines. Relatively little development work had been conducted by General Electric, and the Navy expressed no interest in funding further R&D in the near term. GD had also selected a version of the GE F404 for its twin-engine SX-4. However, its Agile Falcon proposal, as well as its SX-2 and SX-3 variants, had been designed to take advantage of the Improved Performance Engine programs already well under way for the Air Force. These programs aimed at developing upgraded variants of the General Electric F110 and the Pratt & Whitney F100 engines for use on the new Block 50 versions of the standard U.S. Air Force F-16C. Development of these engines was nearing completion in the summer of 1987, thus eliminating the enormous cost and technological risk of separate engine development for the SX-2 and SX-3 (Sweetman, 1988, p. 162).

If forced to cooperate on the joint modification of a U.S. fighter, the *kokusanka* supporters, of course, clearly preferred the SX-4 or Super Hornet proposals. However, the FS-X Joint Study Team had been aware for some time of the growing government concerns over the high development costs for these proposals. Indeed, as early as April, Japanese press accounts had reported that the Japanese government favored the SX-2 and SX-3 variants primarily on cost grounds (see Cook, 1987a). Consequently, Japanese industry had already begun looking very closely at ways of achieving its agenda of national R&D and technology objectives within the confines of the SX-2 and SX-3 proposals in the event the government refused to fund the SX-4 or Super Hornet. Government concern over costs was also one of the principal reasons Japanese industry began independently assessing an indigenous modification program based on the licensed-produced F-15J during the spring. Thus, GD's announcement of the withdrawal of the SX-4 at the August industry meetings did not prove to be the show stopper that the U.S. side had expected. To the contrary, the Japanese industry team came prepared with an extensive list of changes and additions to the basic SX-2 and SX-3 proposals intended to transform these Agile Falcon derivatives into something much closer to the indigenous Japanese fighter it so deeply yearned to develop.

Apparently, the first formal discussions about incorporating Japanese-developed avionics systems and other indigenous technologies into one of GD's SX proposals took place during the meetings at Fort Worth in August. The most important avionics system, of course, was MELCO's APA fire-control radar. Other systems included the central mission computer, the inertial reference system (IRS), and the integrated electronic warfare system (IEWS). The Japanese also stressed the importance of applying their cocured composite wing and CCV technologies.

U.S. observers came away from these meetings with the impression that the Japanese industry team still strongly preferred independent national development, but continued to support the Super Hornet option if forced to collaborate because it represented the maximum development work.²⁵ McDonnell-Douglas had pre-

²⁵Another widespread theory among U.S. participants at the time was that Japanese industry pushed for the most expensive U.S. proposal in the hopes of pricing collaboration out of the competition and making indigenous development

sented a more detailed modification proposal based on the new F-15E program, but the visitors seemed more interested in the F-18. Japanese press accounts claimed that McDonnell-Douglas seemed the most willing of the two American contractors to incorporate the maximum amount of Japanese technology into its proposals (Kohno, 1989, p. 469). According to one source, the Japanese industry team, after returning home, formally recommended elimination of the F-16 and F-15 proposals from the competition, urging indigenous development as the preferred option, followed by cooperative development based on the F-18.²⁶

However, opposition within the Japanese government to the Super Hornet because of high development costs was becoming insurmountable. In September, the Japanese government apparently made the final decision to reject domestic development and base the FS-X on a U.S. fighter. Shortly afterward, the government also overruled the industry recommendations on collaboration candidates, eliminating the F-18 and shortening the list to the F-16/SX-3 and F-15J modification proposals.²⁷

Once again it appeared that the hopes of the *kokusanka* supporters had been dashed. However, despite the reports of McDonnell-Douglas's greater willingness to compromise, Japanese industry could still find considerable comfort in the overall receptiveness of GD at the August meetings to its demands for incorporating indigenous technology. GD apparently raised few objections to substituting Japanese avionics for U.S. systems on the SX-3 design. The only airframe modification that seemed to be required was an enlarged nose radome to accommodate MELCO's APA radar. Another relatively minor airframe change—insertion of a "plug" in the fuselage to extend its length—appeared to be an acceptable change to meet other Japanese requirements. GD had experimented with advanced CCV technology using vertical chin canards and a digital FBW system on its AFTI F-16 in the early 1980s; therefore, it believed it could accommodate Japanese demands for a similarly configured system building on the Mitsubishi

look more appealing to the Japanese government (*Aerospace Daily*, September 9, 1987; Button, 1989b, pp. 17-18).

²⁶Heginbotham and Van Atta (1990); "Japan Narrows FSX Choice to F-15, F-16" (1987).

²⁷Heginbotham and Van Atta (1990); "Japan Narrows FSX Choice to F-15, F-16" (1987).

T-2 CCV demonstrator program that had completed flight testing only the previous year (see Chapter Four). The U.S. company also seemed willing to incorporate the Japanese-developed composite wing technology. Thus, GD had essentially accepted all the most important national technology objectives and subsystems under development for the Rising Sun fighter for use on the SX-3.

GD christened the new Japanese-inspired version of its baseline design as the SX-3 "Upgrade." The extensive changes hiding behind this benign term would later come back to haunt officials on both sides of the Pacific.

U.S. Acceptance of Japanese Changes to the SX-3

It is difficult to square the easy acceptance of the Japanese technologies and subsystems by the U.S. contractors with many of the Pentagon's stated goals for collaboration. But as a prime contractor and airframe developer who subcontracted to other firms for most major subsystems, GD, of course, had no particular commercial incentive to insist on installing U.S. avionics, particularly if such a demand would undermine its chances of winning the FS-X airframe competition. Although possessing little detailed information about MHI's composite wing technology, GD clearly was intrigued with the prospect of learning more about the Japanese developments in this area.

It will be recalled that, in 1986, GD, teamed with McDonnell-Douglas, won a design contract from the Navy for the secret ATA, later called the A-12. Unlike the YF-22 ATF prototype program on which GD was a junior partner, the A-12 program was structured with an equal split of workshare and program responsibility between the two contractors who were competing head-to-head on the FS-X.²⁸ The A-12 had stringent stealth requirements for the minimization of radar cross section. GD and McDonnell-Douglas designers focused on highly unconventional configurations, such as a featureless delta flying wing that depended heavily on complex CFC structures and their manufacturing technologies to achieve

²⁸GD, teamed with Lockheed and Boeing, won a U.S. Air Force contract in late 1986 to develop the YF-22 prototype for a fly-off competition against the Northrop/McDonnell-Douglas YF-23. The work split gave GD the center fuselage and tail, while Boeing took the wing and aft fuselage. As lead contractor, Lockheed had responsibility for the forward fuselage and final assembly. See Morrocco (1990).

the necessary stealth characteristics and reductions in airframe weight. Industry observers, however, did not generally view GD as a leader in airframe composites technology. Unlike McDonnell-Douglas, GD had never developed a production fighter that extensively employed composite materials in major load-bearing structures. Some observers questioned the capability of the company to meet the demanding challenges the A-12 posed in this area. With the A-12 contract award for full-scale development anticipated before the end of the year, GD undoubtedly listened to MHI's expansive claims about its all-composite cocured wing and tooling development programs with great interest.²⁹

Nonetheless, extensive incorporation of Japanese technologies into the SX-3 seemed to contradict the Pentagon's stated collaboration goals of reducing acquisition costs and achieving greater standardization and interoperability with U.S. forces through procurement by allies of the same or very similar aircraft. Yet there appears to have been no significant opposition in DoD to, or clear understanding of, the Japanese industry strategy at this time. It is possible, however, that DoD negotiators did not fully comprehend the true extent of the modifications to which GD and MHI had agreed. GD representatives, however, claim they routinely briefed DoD and other government officials on the progress of the technical negotiations with Japan and the evolution of the design proposals but were never given specific guidance on this issue.³⁰

One obvious explanation would be Pentagon interest in gaining access to the new Japanese technologies under development for the indigenous FS-X. Yet this does not seem to have been the case at this time. The findings of the Sullivan team visit to Japanese industry in the spring had inspired little DoD interest in acquiring Japanese technology. Pentagon officials still knew very little about the APA radar and other indigenous avionics, but remained generally skeptical. Considerable doubts also persisted about the MHI composite wing. Pentagon officials had viewed a specimen wing-box structure at MHI, but it was a long way from a full-scale, aero-

²⁹In 1990, two and a half years after the GD/McDonnell-Douglas team won a contract for full-scale development of the A-12, the press began reporting significant technical difficulties and cost growth allegedly resulting in part from problems with fabrication of large composite parts and their associated tooling. Later, these problems led DoD to cancel the program. See Goodman (1990).

³⁰Interview with a senior U.S. industry official, August 4, 1992.

dynamic wing. Indeed, the Sullivan team findings had been used primarily to bolster the U.S. case against indigenous development (GAO, 1990, pp. 28-29, 31-32).

In short, it appears that DoD was focused almost exclusively on the problems of preventing Japanese indigenous fighter development, basing the FS-X on a U.S. fighter, and gaining major U.S. contractor participation in the program. Pentagon officials apparently did not see incorporation of Japanese technology into a modified U.S. fighter as a major problem and did not particularly view it as an important opportunity to gain access to significant Japanese technical developments. This was particularly true because it appears to have been assumed that U.S. industry, with its far greater expertise, would heavily influence the fighter's configuration and development once the program was under way.³¹

Japan Agrees to Cooperative Development of the SX-3 Upgrade

It is not surprising, then, that Pentagon officials were elated over the results of meetings held between Secretary Weinberger and Director General Kurihara and their staffs in Washington at the beginning of October. Armitage and Nishihiro held extensive preliminary discussions primarily devoted to the FS-X issue before the Weinberger-Kurihara meetings. Nishihiro informed his counterpart that JDA had narrowed the choices to the modification proposal developed by Japanese industry in the spring based on the F-15J and to the GD SX-3. He explained that McDonnell-Douglas's Super Hornet and its F-15E proposal introduced in August had been eliminated primarily because of their high cost. Nishihiro praised the SX-3 proposal but noted that it did not meet all

³¹A former U.S. Air Force Program Manager for the FS-X characterized this question as follows:

DoD negotiators understood the extent of the modifications contained in the top level proposals What was not understood by the DoD or GD was that MHI planned to use the F-16 data as reference data rather than do an ECP (Engineering Change Proposal) to the F-16. MHI's goal was to develop a trained work force and do "their own thing." Working level JDA had the same goal. GD and DoD underestimated this. After the program started in March 1990 MHI made no attempt to develop a lightly modified F-16 and the U.S. had no authority—in the agreements—to temper MHI's "creativity." (Letter to the author, Major Craig Mallory, August 9, 1993.)

Japanese FS-X requirements. However, he argued that there were “technical solutions” to this problem and that application of the right technologies to the SX-3 could make it a very strong candidate. He requested new industry meetings in Tokyo the following week to help resolve these technical issues, stating that JDA planned to pick the winning baseline fighter by October 20 (Button, 1989a, p. 23).

The next day, October 2, Weinberger and Kurihara formally agreed on the collaborative development of the FS-X based on a “lightly modified derivative” of either the F-15 or the F-16.³² Shortly thereafter, Kurihara made it clear that this decision had been based primarily on political considerations in the interests of preserving the U.S.-Japan security relationship (quoted in Kohno, 1989, p. 470):

Japan gave up the idea of domestic development of the FSX because [I] thought a decision aimed at maintaining good relations with the U. S. based on the Japan-U.S. Security Treaty was important.

The following week, GD and McDonnell-Douglas scrambled to put together their final and best offers on the SX-3 and F-15 modification proposals. JDA submitted another lengthy technical questionnaire that had to be completed before the visit. On October 12, the final round of industry presentations and discussions got under way in Tokyo, lasting several days and focusing primarily on technical issues. Eleven days later, on October 23, JDA made its final decision: The FS-X would be cooperatively developed with the United States based on the GD SX-3 modification of the F-16C. The same day, Prime Minister Nakasone and the Cabinet approved the decision. After two and a half years of pressuring the Japanese government, DoD had succeeded in stopping the Rising Sun fighter—or so it appeared.³³

There was no official explanation offered for the selection of the SX-3 over the F-15. Again, some observers were surprised, since the F-15 met the ASDF requirement for two engines, and the SX-3 did not. Lower projected R&D and procurement costs seem to

³²“Japan Narrows FSX Choice to F-15, F-16” (1987).

³³“Japan’s Defense Agency Selects F-16 as Basis for FS-X Aircraft” (1987).

have been a decisive factor, as apparently was the case in the earlier elimination of the Super Hornet Plus. Some observers believed that domestic political concerns played an important role: The longer range of the F-15 made the McDonnell-Douglas fighter appear more capable of offensive operations, and thus less politically acceptable to the Japanese Diet. Others speculated that Japanese industry sought access to GD's technology and techniques after having collaborated for years with McDonnell-Douglas on the licensed production of the F-15 and the F-4 Phantom. A widespread interpretation at the time claimed the F-16 derivative offered Japanese industry the greatest latitude for indigenous modification and incorporation of domestic technology.³⁴

Another interesting theory holds that once collaboration became unavoidable, the *kokusanka* supporters purposefully pushed for selection of the least-capable U.S. aircraft. According to this theory, Japanese officials decided to make the best of an undesirable situation by treating a collaborative FS-X as only a temporary placeholder for a future indigenous fighter with higher performance. With FS-X based on a less-capable single-engine U.S. fighter, ASDF and TRDI could argue more convincingly that it could never serve as an adequate replacement for the two-engine F-4 or F-15 that would be needed early in the next century, thus increasing the prospects for launching a new indigenous fighter program soon after completion of FS-X R&D.³⁵

While all these factors may have been important, it appears that the primary reason the Japanese government opted for a modification of the F-16 was that it viewed this option as the least expensive approach. By the spring of 1987, the MOF and other government agencies had clearly become increasingly concerned about the high projected development costs of many of the competing proposals. It seems that these concerns played a decisive role in selecting the F-16/SX-3.

Selection of the SX-3 undoubtedly disappointed some of the *kokusanka* supporters who viewed the Super Hornet design as providing greater opportunities for Japanese industry to pursue

³⁴See "Japan Will Build F-16 Under License" (1987); "Japanese Announce F-16 for FSX" (1987); Chinworth (1992), p. 147; Shinji (1988); Kohno (1989), p. 470; Heginbotham and Van Atta (1990).

³⁵Interview with a U.S. government program official.

independent R&D. However, mere acceptance of the SX-3 proposal as the basis for collaboration hardly locked the Japanese into a modest program for developing a minimally modified F-16. The Japanese supporters of indigenous development believed there was still ample opportunity to formulate a final program structure that would promote many of the original objectives of indigenous development.

JDA's decision for collaboration on the SX-3 merely marked the opening of a new and even more difficult phase in the ongoing struggle between the U.S. side and the *kokusanka* supporters. All the most fundamental program characteristics such as workshare, program oversight, and technology transfer policy remained unsettled and ambiguous. Indeed, the political decision to cooperate on the SX-3 only momentarily obscured the fact that the two sides, at least on the working level, still adhered to profoundly differing conceptions of the basic nature of the program.

The Pentagon believed it had gone to considerable lengths to accommodate Japanese industry interests. While Congress clamored for the direct purchase of an existing U.S. fighter, DoD had compromised on cooperative development of a modified U.S. aircraft. Although accepting Japanese demands for incorporating indigenous avionics and technology, DoD still viewed the SX-3 as basically a "lightly modified" Agile Falcon that would be part of a larger international effort to standardize allied fighter inventories.³⁶ Immediately following the Japanese selection of the SX-3, the Pentagon announced official backing for a major new marketing push by GD to bring the European F-16 operators, and possibly the Israelis, into an expanded Agile Falcon program. With the Japanese indigenous fighter dead and the Lavi canceled, the Pentagon clearly hoped to follow through against the increasingly shaky EFA, Rafale, and Gripen to bring as many allies as possible into a single large international program to build an essentially common, lower-cost fighter based on the Agile Falcon design.³⁷

The *kokusanka* supporters viewed the program quite differently. The Japanese had agreed to cooperate on developing

³⁶Indeed, "government and industry sources" went so far as to characterize the Japanese selection to the authoritative *Aerospace Daily* as a decision to "build [the] F-16 under license." "Japan Will Build F-16 Under License" (1987).

³⁷Lucas and Walker (1987), p. 975; Gilson (1987).

the "SX-3 Upgrade," as GD called it after the August industry meetings, which included the four major indigenous avionics systems, the enlarged radome for the APA radar, a redesigned cockpit and canopy with Japanese-developed flat-panel liquid-crystal displays, two vertical chin canards, domestic CCV technology, a stretched fuselage, indigenous "stealth" features, and the Japanese-developed composite wings.³⁸ The overall design remained preliminary and required considerable additional definition and refinement. Project control and leadership had not been fully determined.

Japanese industry had been forced by U.S. political pressure and domestic budgetary realities to progressively retreat from each of its preferred positions, starting with domestic development, followed by codevelopment of a new design, then cooperative development of a radically modified U.S. fighter (SX-4, Super Hornet Plus), and ending with the SX-3 Upgrade. Throughout this process, the *kokusanka* supporters struggled to preserve their basic objectives of Japanese control over R&D and maximum application of indigenous technology. In October 1987, the SX-3 Upgrade design proposal and the details of the actual collaboration program remained so ambiguous and ill-defined that considerable latitude remained to achieve the original Japanese industry objectives, given an appropriate final program structure.

³⁸"Japanese Council Approves Selection of Modified F-16 for FS-X" (1987).

THE STRUGGLE OVER PROGRAM CONTROL

A DIVIDED U.S. GOVERNMENT CONFRONTS THE KOKUSANKA SUPPORTERS

Shortly after the selection of GD's SX-3 design proposal in October 1987, U.S. and Japanese officials began the long and arduous task of negotiating a detailed governmental framework for cooperative development of the FS-X. At about the same time, GD and Japanese industry launched parallel discussions aimed at defining the industrial structure of the program. This chapter reviews the difficult negotiations the DoD conducted with Japanese officials from late 1987 through early 1989 to establish an acceptable government framework for cooperative development of the SX-3.

During the crucial negotiations in 1988, and even more so during the public controversy over FS-X that broke out in Congress in 1989, the U.S. government failed to develop a single, coordinated strategy toward the FS-X program that harmonized U.S. security and economic interests. Various elements within the U.S. government pressed differing agendas for the program, which often conflicted with each other.

The Japanese side did not suffer from this problem. As one writer has pointed out, the Japanese working-level officials who negotiated the FS-X R&D MoU represented "the heart of the domestic development alliance: the Air Staff Office, TRDI and the [JDA] Equipment Bureau," supported by MITI (Noble, n.d., p. 20). The senior political leadership, MOFA, and the MOF had forced cooperation on this alliance because of political pressure from the United States; they then left the *kokusanka* leaders on their own to

negotiate the program details with the Americans. The *kokusanka* supporters' central goal remained clear and unambiguous: a program structure that provided the latitude to transform the collaborative FS-X as much as possible into the indigenous Rising Sun fighter.

The U.S. negotiators, primarily representing the Pentagon and supported by the Department of State, sought exactly the opposite outcome: provision of sufficient U.S. control over the program to minimize Japanese modifications and maximize commonality with existing or planned U.S. fighters. However, the job of these negotiators was increasingly complicated by an additional agenda of objectives, often closely related but not central to the main DoD goals. This agenda arose primarily from congressional and DoC concerns about jobs, the trade deficit, and industrial competitiveness. During the negotiations over the FS-X program framework, these economic concerns translated into the increasingly contentious issues of workshare and technology reciprocity.

The last two issues and, most important, the problems of technology flowback and access to Japanese technologies eventually emerged as the most fractious areas during the negotiations, because they came to embody both the essence of the ongoing conflict between the fundamentally opposing views of the collaborative program taken by the security establishments of both sides and the broader economic frictions between the two countries. More important for the future of the program, the emergence of these two issues reflected a widening disagreement within the U.S. government over whether to focus on security or economic objectives during the negotiations.

Throughout 1988, some members of Congress increasingly began to view the proposed joint FS-X program as a "technology giveaway" that would transfer jobs and American high technology to a formidable and sometimes unfair economic competitor that could use that technology against American firms in the aerospace and other commercial sectors. Thus, limiting technology transfer to Japan and gaining a significant share of FS-X R&D and production work became crucial political objectives intended to preserve jobs and protect U.S. industrial competitiveness. The concept of technology reciprocity was meant to help "level the playing field" in the economic competition between the two countries by promoting a greater two-way flow of high technology. The supposedly broad

economic and commercial benefits gained by Japanese firms through the transfer of U.S. military technology would be balanced by the requirement to "flow back" Japanese modifications and improvements made to that technology to U.S. companies. As it became increasingly clear that FS-X would incorporate substantial Japanese technology, Congress began raising the demand for guaranteed access by U.S. industry to Japanese domestic technical developments to compensate the United States for the transfer of valuable U.S. technology to Japan.

To the DoD and Department of State officials conducting the framework negotiations, however, the single most critical problem they confronted remained simply stopping the resurgent *koku-sanka* supporters and ensuring the program remained as close as possible to a licensed-production effort. The central issues for them were military and strategic, not economic: keeping Japan's military industry and government security policies firmly aligned with, and subordinate to, U.S. interests by ensuring that the FS-X program represented a cost-effective and mutually beneficial example of defense burden-sharing. Thus, because its primary objective was to maintain U.S. influence and control over the R&D program, DoD initially targeted program oversight arrangements and U.S. industry participation in R&D as the critical issues during the negotiations over the program framework.

At the beginning of the talks, the Pentagon had relatively few concerns about technology transfer to Japan, because its primary interest here was in defense technology security and because it already had high confidence in its existing procedures and oversight mechanisms to control the security problem. Furthermore, DoD officials doubted the commercial utility of the vast bulk of the F-16 technical data that would be transferred to Japan. Finally, and perhaps most important, Pentagon officials recognized that minimizing Japanese modifications and applications of new technology to the baseline F-16/SX-3 design concept depended on transferring extensive U.S. technical data to Japanese industry. If Japanese industry did not have the plans and processes for duplicating important designs and components of a U.S.-designed aircraft, it would surely develop its own. By conducting its own full R&D process, Japanese industry could learn far more about the complex design, development, and integration processes than through licensed production of American items and designs. Such experience

could significantly enhance the independent R&D capabilities of the Japanese military aerospace sector.

Initially, DoD officials viewed the flowback of Japanese improvements to U.S. technology and access to indigenous technology as important political components of the negotiations necessary to satisfy congressional concerns, which conceivably could eventually provide some real benefit to American defense industries. Technology reciprocity, however, was far from being seen as a central objective of the program.

As the negotiations with Japanese officials over program structure dragged on through 1988, however, the concept of technology reciprocity became a tool used by the Pentagon team to win involvement in, and exercise greater influence over, the actual content of the R&D program and development of the fighter. The increasingly vocal demands from Congress for greater technology reciprocity and significant U.S. workshare provided the DoD negotiators with the necessary political leverage to demand U.S. industry participation in key aspects of the program—most importantly, the wing. The issue of technology reciprocity became a vehicle used to debate the origin and control of technology applied to the program and thus served as a surrogate for the more fundamental dispute between the two security establishments over what kind of fighter the FS-X would end up being: a slightly modified F-16 or the indigenous Rising Sun fighter with “an F-16 logo on it.” Although the Pentagon pursued this strategy with reasonable success during the MoU negotiations, the question of technology reciprocity and other economic issues had become far more prominent by early 1989 than the DoD originally intended. These issues would later come back to haunt the U.S. negotiators and would ultimately undermine their higher-priority objectives.

INITIAL DISCUSSIONS ON A PROGRAM FRAMEWORK

In the initial negotiations for a program structure for FS-X, begun in October 1987, the Pentagon focused almost entirely on ensuring significant U.S. government and industry influence over the R&D effort. Many DoD officials recognized that the SX-3 upgrade proposal was hardly the “lightly modified” American fighter that Director General Kurihara called it when announcing the agree-

ment. Indeed, one prominent Japanese aerospace analyst had boasted at the time that Japanese industry had gotten most of what it wanted out of the FS-X agreement: "In the end, 80% of [the FS-X] will be Japanese."¹ Another industry observer noted that

[I]t looks like it will have an F-16 logo on it But if they modify it as much as they plan, the only thing they haven't modified is the name.²

That eventual outcome remained a realistic possibility in October 1987. None of the most basic issues of collaboration, such as responsibility for final design configuration, program oversight, the division of tasks and responsibilities, and technology access, had yet been seriously raised. The actual character of the program would ultimately depend less on the high-level political decision to cooperate than on the working-level formulation of the details of program structure and implementation.

From the perspective of the supporters of *kokusanka*, the SX-3 collaboration could still be transformed into something approximating domestic development, with one major additional benefit: extensive access to U.S. industry technology and R&D expertise. Indeed, as various MITI officials had argued for some time, even the original conception of a totally indigenous FS-X would have greatly relied on foreign expertise, technology, and subsystems.³ The decision to cooperate in October merely formalized that relationship, providing the possibility of even greater access to American expertise in support of Japanese industry objectives. The key to the realization of these objectives rested in the negotiations over a framework document between the two governments and a commercial and workshare agreement between GD and Mitsubishi that would define the actual program structure.

The profound differences that still remained between the Japanese and DoD conceptions of collaboration arose almost immediately during the first preliminary discussions about program structure that preceded the final selection of the SX-3 in late 1987. During the concluding visits by the two U.S. industry teams to

¹Eiichiro Sekigawa, quoted in Lachica (1987b), p. 34.

²Eiichiro Sekigawa, quoted in Lachica (1987b), p. 34.

³"Military Power: Ultimate US-Japan Friction" (1990), p. 16.

Japan in October following the decision in principle to modify a U.S. fighter, American company officials brought up workshare issues for the first time in a significant way. McDonnell-Douglas essentially proposed a workshare comparable to that on the F-15 licensed-production program. GD insisted on significant participation in both development and production. American government officials accompanying the industry teams immediately recognized the potential for a bidding war on workshare between the two U.S. contractors to win the final contract. Consequently, the U.S. government side requested immediate guidance from Washington (Button, 1989a, pp. 23-24; Button, 1989b, p. 19).

Pentagon officials were intent on guaranteeing significant U.S. industry involvement in the program, particularly in the R&D phase. However, specific work division or allocation of tasks had not been carefully examined, in part because the winning design had not yet been chosen, but also because all the modification proposals were preliminary "paper airplanes" that required considerable further design definition and refinement. Faced with the need for a rapid response to the request for guidance from the U.S. team in Tokyo, Pentagon officials essentially pulled some numbers out of the hat that seemed reasonable in view of the basic U.S. objectives. This initial DoD guidance stipulated 40 to 60 percent U.S. participation by value in R&D and 30 to 70 percent in production (Tolchin and Tolchin, 1992, p. 99).

These figures clearly suggest that DoD placed the higher priority and permitted less flexibility on the development side of the program, aiming to keep roughly half the work in U.S. hands, since the R&D component of the agreement would determine oversight and control of design and technology development and transfer. The production side was more akin to a traditional coproduction program in which the central issues were more likely to focus on jobs and money, not on design, configuration, and military technology (Button, 1989a, pp. 23-24; Button, 1989b, p. 19).

Confronted with the DoD workshare guidelines, Japanese industry officials remained essentially noncommittal. Later in the week, U.S. government representatives met with senior officials from the JDA Equipment Bureau to review approaches to an overall program framework. The Japanese surprised their guests by presenting a prepared draft proposal for U.S. consideration. The draft proved to be completely unacceptable from the American per-

spective. It demonstrated how committed the Japanese working level was to salvaging the most important components of an indigenous development program within the context of a collaborative effort. According to one source, the key points of the Japanese proposal were as follows (Prestowitz, 1989b, p. 34):

- All development work would be carried out in Japan.
- All R&D program funds would be spent in Japan.
- A Japanese company would be prime contractor.
- Transfer of F-16 data and technology to Japan would be unrestricted.
- U.S. industry engineers would be assigned to the Japanese R&D team to provide assistance.
- U.S. access to Japanese technology would be determined on a case-by-case basis through the JMTC, as guided by the terms of the 1983 Exchange of Notes.
- JDA would retain all patent rights.
- Japan would pay a \$500,000 license fee for each plane produced.

Other sources have confirmed most of the elements in this list (Button, 1989a, pp. 23–24; Button, 1989b, p. 19).

Because the Japanese draft violated most of the key principles established by the Pentagon to guide the program, its complete rejection was inevitable. Its most serious shortcoming from the DoD perspective was its proposal for conducting all R&D work in Japan by Japanese companies. In addition, the JDA draft framework contained no mention of any arrangements for the production phase. Although DoD officials were most concerned about the R&D workshare, they were particularly sensitive to the latter omission, because they anticipated a strong adverse reaction from Congress to any agreement that did not guarantee significant U.S. production work. The Japanese officials explained that JDA's budgetary procedures and regulations did not permit specification of production arrangements in an R&D agreement. Furthermore, they noted that Director General Kurihara and Secretary Weinberger had only discussed joint *development* during their recent high-level meetings (Button, 1989a, pp. 23–24; Button, 1989b, p. 19).

Early Signs of Technology Flowback as a Central Problem

At these meetings, U.S. officials also raised the issue of technology "flowback" on the FS-X for the first time. It will be recalled that DoD officials first insisted on provisions for mandatory and free flowback to the United States of Japanese improvements to American technology transferred in licensed-production programs during the negotiations for a new F-15J licensed production agreement in the second half of 1984 (see Chapter Two). After considerable delay, JDA had finally accepted the U.S. position. The flowback provisions in the 1984 F-15 MoU became the model for all subsequent licensed production agreements with Japan, including the MoU for the Sikorsky SH-60 Seahawk helicopter that JDA extensively modified and equipped with Japanese avionics (see Chapter Four). However, little if any flowback of improved U.S. technology had actually resulted from any of these agreements.

DoD officials had paid scant attention in the drafting of the SH-60 MoU to an issue that would later become central to the FS-X dispute: U.S. access to Japanese-developed technologies, as most clearly represented by the indigenous avionics systems.⁴ And, of course, the question of indigenous technology was generally irrelevant to more conventional licensed-production programs. Completely separate negotiations, it will be remembered, had earlier led to the establishment of the JMTC in late 1983, which was tasked specifically with identifying Japanese defense-related technologies of interest to the United States and facilitating their transfer. However, the implementation agreement signed in December 1985, the "Detailed Arrangements for the Transfer of Military Technologies," required separate JMTC consideration of each specific technology the United States requested. This provision necessitated approval of each request by the Japanese JMTC members representing JDA, MITI, and MOFA. In addition, the Detailed Arrangements called for negotiation of a separate Memorandum of Implementation for each U.S. technology request (see Chapter Two). Not surprisingly, this complicated and unwieldy process had led to the transfer of only a handful of relatively minor technologies.

⁴Interview with a former DSAA official, August 7, 1992.

When the Pentagon team finally brought up the question of technology "flowback" during the FS-X discussions in Tokyo in October 1987, the door was opened for the first major confrontation over these many unresolved problems affecting technology transfer and U.S. access to Japanese defense-related technologies. The earlier DoD efforts dating back to the late 1970s had largely focused on low-visibility programs and generic technologies of relatively minor public interest. But the FS-X program had already become fully politicized and clearly linked by Congress to general U.S.-Japan trade frictions. Furthermore, the technology-transfer issues facing the FS-X negotiators were infinitely more complex because of the unprecedented but ill-defined framework of cooperative development, the potentially high content of Japanese indigenous technology, and the continuing struggle between the two sides over the basic definition and nature of the program.

The initial exchanges of views on technology flowback on the FS-X program revealed the fundamental differences in perspectives. The American side assumed that any program framework document would include the now-standard provision for free and automatic flowback of all Japanese improvements to U.S. technology. To the consternation of the Pentagon negotiators, however, the JDA officials insisted that U.S. requests for technical data should be funneled through the JMTC review process (Button, 1989b, p. 19).

These two opposing positions clearly indicated that the political decision to collaborate had done little to close the huge gap between the original program objectives of the *kokusanka* supporters and those of the Pentagon. The DoD position on flowback arose from the assumption that the collaborative FS-X would be a relatively modest modification of GD's existing Agile Falcon design, which itself was a direct derivative of the F-16, or the McDonnell-Douglas/MHI F-15J modification proposal. DoD thus based its position on the precedents established by the renegotiated 1984 MoU for the F-15 and all subsequent major licensed-production agreements, including the Japanese-modified SH-60. The JDA position, however, suggested that the Japanese still intended to transform the collaborative FS-X into an essentially indigenous development, with formal U.S. industry assistance. The JMTC, of course, had been established primarily to facilitate identification and transfer of domestically developed Japanese technologies to the United

States. JDA insistence on designating the JMTC mechanism for technology transfer to the United States indicated the Japanese still sought to develop the FS-X based largely on indigenous technology and R&D.

The Tokyo meetings adjourned without resolving these problems. Aside from the conflicting positions on technology flowback, the Japanese omission of R&D sharing and production arrangements in their draft framework document stood out as the most serious and potentially most explosive political problems from the U.S. perspective at the time. However, the JDA officials agreed to reconsider their framework proposal after consulting with MOFA and to present a revised draft to U.S. officials for further discussion at the upcoming annual meeting of the DoD-JDA S&TF meetings, scheduled for November (Button, 1989a, p. 24).

Forging a Consensus Position on U.S. Negotiating Objectives

Throughout the rest of October and into November, DoD officials conducted a series of meetings in Washington with a variety of interested Pentagon and Department of State agencies and offices, Air Force representatives, and industry officials to formulate a coordinated U.S. negotiating position on the collaboration framework for discussion during the S&TF meetings. The Pentagon's four basic objectives for the FS-X program framework that eventually emerged from these discussions were

- U.S. involvement in program oversight
- U.S. industry participation in R&D
- U.S. workshare during the production phase
- Technology flowback to the United States.

DoD officials extensively reviewed workshare goals and technology-transfer issues with GD and the three major U.S. F-16 subcontractors: General Electric and Pratt & Whitney for the engine and Westinghouse for the fire-control radar. These government and industry meetings focused on a multiplicity of details, but most related to the central issues of program oversight, configuration control, workshare, and technology transfer. The basic ob-

jectives were to ensure significant U.S. influence over the design and technical evolution of the R&D program, guarantee quality workshare⁵ for U.S. industry in both R&D and production, control technology transfer to Japan, and secure the undisputed right to free and automatic technology flowback. A fundamental goal was to keep the FS-X as close as possible to the existing F-16/Agile Falcon concepts by exercising U.S. influence over design and configuration and by incorporating the maximum amount of U.S. subsystems, components, and parts common to existing or projected U.S. fighters.⁶

During these meetings, there appears to have been no specific concern for structuring a distinct or separate mechanism for gaining access to purely indigenous Japanese technologies. Essentially, the U.S. side viewed the FS-X program as a glorified coproduction effort that included installing some Japanese avionics and MHI's composite wing and possibly applying some other Japanese technologies. Virtually every significant aspect of the aircraft, with the possible exception of the Japanese avionics, was generally assumed to be essentially derivative of U.S. designs and technology. Indeed, at the time of the Japanese decision in October, one U.S. source speculated that the Japanese would likely buy some initial airframes off the shelf from the United States for the purpose of planning the installation of their avionics—like the SH-60 helicopter program—and then license-produce the rest with GD.⁷

Even in the case of the avionics, the ultimate origin of the technology involved did not appear clear-cut. For example, DoD officials met with Westinghouse representatives during this period to determine what interest, if any, they had in the program. Westinghouse expressed virtually no interest in the FS-X, because in its view, the program represented only a one-way flow of technology—from the United States to Japan. The only possible area of inter-

⁵In this context, "quality workshare" refers to R&D work in new, cutting-edge technology, such as advanced composite structures, as opposed to well-known, conventional technology, such as aluminum structures.

⁶Interview with a senior DSAA official, August 6, 1992; Button, 1989a, p. 24.

⁷"Japanese Announce F-16 for FS-X" (1987), p. 115. A week later, after more details of the agreement became known, *Aerospace Daily* radically shifted its interpretation by reporting that the collaborative program called for development of "a virtually new aircraft." See "Japanese Reveal Details of F-16 Conversion to FSX Requirements" (1987), p. 164.

est, according to company officials, was in providing an off-the-shelf back-up radar for MELCO's APA radar in case that development program failed (Button, 1989b, p. 20).

It is unclear exactly why Westinghouse expressed so little interest in the MELCO APA radar. This major U.S. military radar developer was teamed at the time with Texas Instruments to develop an extremely advanced and high-capability APA radar for the Air Force's ATF program. Therefore, one would expect the U.S. firm to have some interest in similar developments undertaken by MELCO. However, Westinghouse had actually nurtured a close working relationship with MELCO over the years, beginning shortly after the Second World War. Some observers claim the U.S. company had some technical knowledge of the MELCO APA radar program dating as far back as the early 1980s.⁸ It is possible that Westinghouse did not see much of direct interest in the MELCO program based on what it knew from its own industry-to-industry contacts. Whatever the reason, the U.S. firm did not push DoD during this period to gain access to Japanese avionics technologies.⁹

The DoD discussions with GD officials produced somewhat different results. Company officials strongly desired involvement in the Japanese composite wing program for the FS-X. However, at this time, GD viewed this as primarily an R&D workshare issue, not a question of gaining access to a Japanese data package on a mature and fully developed indigenous technology. GD wanted to work closely with the Japanese companies on every phase of the design and full-scale development of the cocured wing. Based on the Sullivan Team visit, the U.S. side considered the Japanese wing development program to be in a very preliminary stage. Consequently, GD's potential involvement was seen as a cooperative full-scale development effort based partly on preliminary Japanese R&D but also including considerable GD contributions in design, engineering, and technology. In short, GD sought to use the FS-X program as a vehicle to advance and refine its own company skills further in developing and producing large cocured composite struc-

⁸Interview with Dr. Barry Spielman, October 13, 1992.

⁹However, the Pentagon did attempt to acquire more data on MELCO APA radar technology in early 1988 to assess its potential value to U.S. industry. According to GAO, "little information was provided" by the Japanese. (GAO, 1990, p. 29).

tures, with an eye to the A-12 program that it had just won with McDonnell-Douglas, as well as the Agile Falcon and ATF efforts (Chinworth, 1992, p. 148). It welcomed any new techniques or processes that could be gleaned from prior Japanese R&D efforts on the wing, but the main selling point for GD was that the FS-X wing offered the company a potentially useful experience of learning by doing, paid for entirely by the Japanese government.¹⁰

A closely related benefit from GD's perspective was that the company could potentially gain enormous experience by participating in what everybody on the U.S. side considered to be a very high-risk technology-demonstration effort, without facing the associated domestic political costs of possible failure. GD would not have to face the wrath of the U.S. government, the Air Force, Congress, or the U.S. taxpayer if the wing development effort did not succeed as advertised. Indeed, U.S. Air Force and industry technical experts were amazed that the Japanese apparently were planning to make no provision in their program for a backup conventional aluminum wing in case the high-risk composite wing R&D effort failed to pan out. This oversight seemed particularly imprudent given the recent experience of the Israelis on the Lavi. In collaboration with Grumman, the Israel Aircraft Industry had hoped to develop an all-composite bonded wing for its prototype fighter. However, the wing structure failed disastrously during ground static fatigue tests, putting the developers into an extremely embarrassing political situation that almost resulted in early cancellation of their fighter program. The Israelis had to scramble frantically to develop quickly a backup wing with more-conventional metal structure and composite skins (see Lorell, 1989, p. 34). GD had followed a similarly conservative approach on its original Agile Falcon wing proposal because of such potential risks of failure, planning a similar composite-skinned wing with internal metal structure. However, GD now perceived a golden opportunity with the FS-X to pursue high-risk experimentation with all-composite wing technology that could possibly be applied to the A-12 and other U.S. programs but that would represent virtually no monetary or political risk to the corporation.

¹⁰Interview with a senior U.S. industry official, August 4, 1992; Button (1989b), p. 20.

Thus, in late 1987, the Pentagon did not view specific access to Japanese indigenous technology as a separate and distinct issue for negotiation. The U.S. side was mainly concerned with the issue of technology *flowback*, with its exclusive focus on U.S. technology modified or improved by the Japanese. The other key technology issues for DoD revolved around the questions of U.S. workshare and control of the transfer of U.S. technology to Japan. On a more fundamental level, these technology concerns also reflected a desire to exercise firm control over the final FS-X design and configuration—strongly supported by the U.S. Air Force—to keep the FS-X as close as possible to the Agile Falcon concepts of interest to the Air Force and other allies in Europe. In this way, DoD and the Air Force hoped to control R&D costs and promote greater allied equipment standardization.

Several fundamental principles emerged from the round of meetings the Pentagon conducted in Washington that were intended to generate guidance for the U.S. team during the upcoming negotiations over the program framework. First, to impose discipline and ground rules on the industry relationship, DoD decided to insist on achieving a formal government-to-government agreement prior to any industry-level agreements. The government agreement had to include Japanese acceptance of two central conditions: (1) establishment of a bilateral standing committee to provide joint government oversight throughout the life of the program and (2) the guarantee of free and automatic flowback of derived technology. Second, agreement had to be reached on the principles governing technology transfer to Japan and for the division of work on both development and production. DoD settled on a minimum goal of about 40 percent of R&D work for U.S. industry. The Pentagon decided to seek a similar percentage for production work but would accept a lower percentage as long as it remained equal to or above McDonnell-Douglas's current workshare on the F-15J licensed-production program. Finally, GD had to be designated the sole point of contact for U.S. industry to facilitate U.S. government supervision of the U.S.-Japan industry relationship. Again, there was no explicit focus on gaining access to distinctly indigenous Japanese technology separate from the concept of free and automatic flowback (Button, 1989a, pp. 25-26).

Countering the Japanese Proposals

These principles formed the basis for the American negotiating position during the first formal round of discussions with the Japanese during the S&TF meetings that took place in Washington in late November. Director General Yamamoto, head of the JDA Equipment Bureau, led the Japanese team, which included technical and legal experts and representatives of MOFA. Senior officials from DSAA led the American team. The Japanese accepted the principle of a joint DoD-JDA oversight committee reasonably quickly—although not without considerable debate—and also the need to formulate basic guidelines for workshare and technology transfer. However, the negotiations soon bogged down when the two teams turned their attention to the substance and details of the proposed agreement.

The discussions got off to an inauspicious start when the Japanese presented a revised draft framework document that differed little from the initial version the Americans had rejected during the October sessions in Tokyo. Once again, the major stumbling blocks concerned flowback of derived technology, workshare, and transfer of U.S. technology to the Japanese. In the American view, the Japanese draft document remained far too vague and loosely worded. Most important, the DoD team gained the impression from the discussions that JDA intended to use GD primarily as a consultant on the R&D program, while granting the U.S. firm virtually no significant role in the actual R&D process. In short, the U.S. team suspected more than ever that the Japanese intended to continue indigenous development under the guise of a cooperative program to develop a “slightly modified” U.S. fighter (Button, 1989b, p. 21).

The Pentagon team, however, granted one key concession during these meetings: JDA program leadership with a Japanese firm, expected to be MHI, as the prime contractor. U.S. officials saw no alternative to this concession; after all, the Japanese government was footing the entire bill for the program (Button, 1989a, p. 27). On the other hand, the program was supposed to be a modest modification of the F-16. GD, of course, was the F-16 prime contractor and had vastly more experience in fighter R&D than MHI. Thus, placing GD in a subordinate role as subcontractor put the U.S. firm in an awkward position and undermined its leverage

when negotiating with MHI. It also encouraged MHI's hopes of gaining the control necessary to transform the SX-3 into something as close as possible to its original objectives.

This problem became immediately evident during the initial meetings in November between GD and MHI to discuss an industry-level framework or License and Technical Assistance Agreement (LTAA). The very name of the agreement echoed the U.S. view of the program as a modest modification effort with major U.S. input. While the meetings were cordial, GD officials detected little Japanese inclination to involve the U.S. firm in the development program beyond the role of consultant and source of data on the baseline F-16 design. Reporting back to the Pentagon on the meetings, GD urged DoD officials to seek a formal government-level agreement that would provide the U.S. firm with the leverage necessary to win a significant role in the R&D program, particularly on the composite wing.¹¹

From these government and industry meetings in late 1987, DoD concluded that negotiating a full-fledged MoU would now be needed to clarify and resolve the differing views the two sides had of the program. U.S. officials believed the negotiations could be facilitated by turning to the familiar MoU format. Furthermore, the precedents established in the 1984 F-15 MoU could be used to bolster the U.S. case for technology flowback. Thus, the Pentagon suggested to the Japanese team that it would prepare a draft MoU and submit it for discussion in early 1988 to provide a basis for further negotiations. The JDA team accepted the U.S. proposal and, along with it, the fundamental DoD principle that a government-level agreement governing the program had to be reached before an industry agreement.

NEGOTIATING A FORMAL MEMORANDUM OF UNDERSTANDING

DSAA led the effort to draft a baseline MoU starting in December. This was merely a continuation of the agency's leadership role on the working-level FS-X negotiations that it had adopted since the receipt of the original JDA request for data on U.S. fighters submitted back at the end of 1985. However, the DSAA staff was

¹¹Interview with a senior U.S. industry official, August 4, 1992.

now entering uncharted waters with FS-X; historically, this agency had dealt with relatively routine off-the-shelf sales to foreign countries and conventional licensed-production programs, such as the European F-16 program or the Japanese F-15J. DSAA had been involved in a few cooperative-development programs, but in most cases the technology flow was clearly and overwhelmingly one way from the United States. But now that FS-X had evolved into something potentially quite different, the rationale for DSAA's leadership role might have seemed less clear. However, it was perfectly consistent with the Pentagon's continuing view of the FS-X program as something that should remain very close to licensed production of a slightly modified U.S. aircraft.¹² Perhaps more important, DSAA leadership would leave the negotiations under the control of the Under Secretary of Defense for Policy, a key consideration given the major foreign policy implications of the effort.

The other participants on the MoU team also reflected this view of the program. The U.S. Air Force representatives came from the Air Force Secretary's acquisition staff and the international program department of the F-16 System Program Office (SPO) at Wright-Patterson Air Force Base. The latter office manages conventional F-16 foreign sales and licensed-production programs. The Defense Technology Security Administration (DTSA) also played a prominent role on the MoU team. The Pentagon established this agency in 1985 to supervise and control the release of U.S. technologies to foreign allied countries involved in licensed production and other cooperative equipment programs carefully, primarily to reduce the risk of sensitive military technologies falling into the hands of the Soviet Union or one of its client states. Thus, the MoU team represented the normal offices and agencies typically involved in standard licensed-production programs. Few members of the team—with the important exception of Jim Auer—appear to have been directly involved with the long-standing effort to gain access to Japanese indigenous technology through the JMTC process that had been conducted out of the Office of the Secretary of Defense.

¹²Indeed, DSAA officials had launched the recently concluded framework discussions with Director General Yamamoto by arguing one more time the U.S. case for traditional licensed production. Needless to say, the JDA representatives did not respond favorably to these arguments. Interview with a senior DSAA official, August 6, 1992.

As DoD officials set out to draft an MoU, the highest priority was still accorded to the issues of meaningful U.S. government involvement in program oversight and significant U.S. industry participation in R&D, followed by the issues of technology flowback and production workshare. A strong voice on a joint government oversight committee with genuine power remained critical for overall U.S. supervision of the program. Gaining significant R&D workshare for GD would enhance U.S. influence over design configuration development and would provide a window on, and access to, Japanese technology developments. The question of ensuring U.S. workshare for the production phase remained an important issue but of considerably lower priority than R&D workshare. Production workshare was not critical to the control of design, configuration, and technology application. Furthermore, DoD officials reasoned that, since the FS-X required an American engine, the production program could be held hostage to U.S. permission to license-produce or purchase the engine during production. Free and automatic flowback of derived technology continued to be a central DoD concern, at least in part as a symbol of technology reciprocity to satisfy Congress.¹³

The Growing Problem of Technology Flowback

The U.S. team completed the draft MoU in February 1988 and forwarded it to JDA. The draft emphasized DoD's four major areas of concern: oversight, R&D participation, production workshare, and derived-technology flowback. The Japanese reviewed the draft for about a month and then countered with their own revised draft MoU. The Japanese version did not address the four critical areas of concern to the satisfaction of the Americans. The Pentagon rejected the JDA draft out of hand, informing the Japanese that no program would take place until its major concerns were met. This rejection was followed over the next three months by a long series of meetings and visits back and forth across the Pacific as negotiators attempted to bring the two sides closer together.¹⁴

¹³Interview with a senior DSAA official, August 6, 1992.

¹⁴Interview with a senior DSAA official, August 6, 1992; Chinworth (1992), p. 149; and interview with a former DSAA official, August 7, 1992.

The general issue of program oversight was eventually resolved first. The negotiating teams agreed to the establishment of a Technical Steering Committee (TSC) with equal representation and cochaired by senior officials from each side. But resolution of the workshare issues proved much more difficult. The Americans continued to push for 40 to 60 percent of R&D and 30 to 70 percent of production. DSAA officials also tried to nail down R&D workshare by actual task, rather than by percentage of the budget. Confirming the suspicions in the minds of many of the U.S. negotiators about ultimate Japanese intentions, JDA continued to fight against anything beyond token U.S. participation. Throughout most of this period, the Japanese held fast to a figure of 20 percent as the absolute maximum U.S. industry share during R&D (Wanner, 1988).¹⁵ The Japanese resisted U.S. demands for guarantees for specific shares of production work even more vehemently than for the R&D phase.¹⁶

Slowly, the negotiators came to closure on the disputes over workshare percentages. Pentagon officials backed down considerably on the issue of production workshare, which they did not view as a key priority at that time. Indeed, the U.S. side completely dropped the demand for inclusion of a specific production percentage for U.S. industry in the MoU, assuming that Japanese use and licensed manufacture of the engine during production would depend on granting U.S. industry a satisfactory production workshare in future negotiations for a separate production MoU. However, they did establish the principle that U.S. firms would receive workshare during production roughly comparable to their R&D share. The Pentagon held fast on its higher-priority objective of specific percentage guarantees of R&D work but made two concessions here also. First, it ultimately accepted 35 to 45 percent, the low end of its range as first established at the end of 1987. Second, DoD dropped the demand to define R&D work division by specific

¹⁵Some observers argue that, with the R&D costs of the indigenous avionics expected to be such a large percentage of total development costs, a significant workshare percentage based on program costs granted to U.S. firms would eliminate Japanese firms from much of the remaining work on the airframe. Furthermore, it appears that MHI had already struck specific understandings for subcontracting work to Kawasaki and Fuji, which it could not keep with major transfers of work to the United States. See Chinworth (1992), p. 148.

¹⁶Interviews with a senior DSAA official, August 6, 1992, and a former DSAA official, August 7, 1992.

tasks, because of the enormous technical difficulty at this preliminary stage in the program in trying to equate specific work tasks with percentages of total R&D program costs or work effort. However, this concession had the unfortunate effect of sidestepping the problem of gaining participation on specific areas of particular interest—most important, the composite-wing work of central concern to GD. Nonetheless, for the time being, the problems of oversight and workshare percentages seemed resolved, at least in principle.

Unfortunately, the last of DoD's four key areas of concern—technology flowback—not only remained unresolved but grew in contentiousness as the negotiations progressed.¹⁷ By the spring of 1988, the issue of technology flowback emerged as the central sticking point in the negotiations.

As noted above, the right to “free and automatic” flowback of foreign improvements or modifications to U.S. technology transferred in collaboration programs had been viewed by DoD as a potentially attractive means of gaining access to important foreign technologies, as well as a symbolic gesture to demonstrate to Congress that the Pentagon was seeking greater technology reciprocity from allies, particularly Japan. Although technology flowback had become a standard provision in MoUs for licensed-production programs, no major instance of actual technology flowback from Japan, at least in a formal sense, had yet been recorded. Many fundamental problems with the concept inhibited implementation. DoD did not have the access to Japanese industry, or the necessary resources and personnel, to track and identify improvements to U.S. technology. The Japanese government and industry rarely appeared cooperative on this issue. In a like manner, no mechanism existed to determine possible U.S. industry or service interest in specific Japanese developments. Indeed, DoD had no clear idea what was actually transpiring on the industry level between the two countries. Some U.S. government officials believed that, occasionally, technology flowback actually took place on an industry-to-industry basis, but for a variety of reasons, U.S. firms

¹⁷Interviews with a senior DSAA official, August 6, 1992, and a former DSAA official, August 7, 1992.

saw no reason to inform the government of these transactions.¹⁸ More often, however, DoD's occasional interactions with U.S. industry on this issue since the early 1980s seemed to indicate little or no real industry interest in the concept.

Nonetheless, technology flowback became *the* central stumbling block in the negotiations during the spring, at least in part because of the growing political importance of technology reciprocity. Congressional concern over the negative effects on U.S. industrial competitiveness caused by the one-way transfer of U.S. technology to foreign allies in cooperative programs had surfaced again in early 1988, driven in part by the publication of a study mandated by Congress and carried out by the Office of Management and Budget (OMB) on industrial "offsets"¹⁹ in collaboration programs. Although the OMB report dealt with issues not directly related to the FS-X program, it served to raise the visibility of the broader economic implications of military equipment collaboration programs. It concluded that offsets and other concessions offered "very limited defense benefits," yet hurt American industry and employment by subsidizing the "development of important or fledgling high technology industries" in competing nations at U.S. taxpayers' expense.²⁰

Staffers on the Senate Armed Services Committee (SASC) began taking a particularly strong interest at this time in the issue of technology flowback. Those working for Senator Jeff Bingaman from New Mexico became especially vocal advocates of the need for including strongly worded provisions requiring technology flowback in collaboration agreements. These staffers regularly communicated their concerns to the Pentagon FS-X negotiators. Although

¹⁸Interview with a U.S. government official, Tokyo, June 11, 1992. Some officials suspect that, occasionally, U.S. firms strike private deals with Japanese firms for derived technology, then try to sell it back to the U.S. government as an indigenously developed U.S. improvement.

¹⁹Offsets are commitments by the seller of military equipment to purchase or seek markets for goods and services produced by the buyer, up to some agreed percentage of the total value of the equipment sale. Direct offsets usually refer to guaranteed subcontracts to the buyer's industries for a percentage of work developing or producing the purchased equipment or related items. The OMB study examined the case of the recent sale of Boeing E-3 surveillance aircraft to France and Great Britain, during which the purchasing countries negotiated the astounding level of 130 percent offsets.

²⁰Quoted in "OMB Case Study Calls AWACS Offset a Mixed Bag" (1988), p. 225.

these interactions remained informal and friendly, they clearly sent a strong message about the political importance to Congress of pressing this issue with the Japanese.²¹

Congressional pressure on both technology flowback and workshare grew dramatically throughout April and May as the SASC debated the fiscal year 1989 defense budget authorization bill. In response to the OMB report issued earlier in the year, senators began considering legislation requiring retaliatory action against nations that demanded industrial offsets in purchase or licensed-production agreements for U.S. equipment. The SASC also turned its attention for the first time directly to the FS-X, openly criticizing the Japanese refusal to buy an American fighter off the shelf. In early May, the committee issued stern and explicit public warnings to the FS-X negotiators. The senators demanded that the FS-X agreement include "meaningful workshare for U.S. industry," and stressed that

the MoU should provide that Japan flows back expeditiously and without charge any technological improvements substantially derived from technology provided by the United States. (Senate, 1989a, p. 109.)

The fundamental issue for the senators was ensuring economic and technological reciprocity. The committee stated in no uncertain terms that an MoU "that simply transfers American technology and jobs to Japan with nothing more than a license fee in return" would be unacceptable to Congress.²²

Serious concern over technology reciprocity on FS-X also started appearing among certain officials in a variety of government agencies and offices dealing with technology policy and trade. In the spring, the president's science adviser began drafting a new government policy framework on collaborative science and technology agreements that stressed the importance of guaranteeing a two-way flow of knowledge and technology to ensure reciprocity and balance. Budding interest in this question and how it related to FS-X also emerged among officials at the DoC and elsewhere (Tolchin and Tolchin, 1992, p. 103).

²¹Interview with a senior DSAA official, August 6, 1992.

²²Senate (1989a), p. 109; "SASC Criticizes Offset Deals, Warns on FSX" (1988).

Such stirrings of potential political opposition from Congress and various executive agencies against any FS-X agreement that lacked sufficient guarantees of technology reciprocity pushed the Pentagon team to place a much greater emphasis on workshare and technology flowback, ultimately transforming them into the central issues of the negotiations. Unfortunately, the Japanese continued to oppose U.S. participation in wing R&D and refused to budge from their initial position regarding technology flowback.

THE CONFLICT OVER DERIVED VERSUS INDIGENOUS TECHNOLOGY

The heart of the problem remained the two sides' differing conceptions of the program. To the Japanese, the FS-X would be a largely Japanese-developed aircraft. Therefore, its technology would be indigenous. JDA negotiators argued that "free and automatic" technology flowback applied only to derived technology, whereas the wing and avionics were indisputably Japanese indigenous technology developed from TRDI and industry R&D programs dating back many years. Therefore, American access to any of the technologies incorporated in these items would have to be considered on a case-by-case basis following formal JMTC procedures. Furthermore, they pointed out that the definitive FS-X design and configuration had not yet been determined and no subsystems and components other than the Japanese avionics had been selected or developed. The completed aircraft could turn out to be considerably different from the existing F-16, with many aspects not "substantially derived" from F-16 technology. Therefore, they argued, including a blanket flowback provision in the FS-X MoU similar to those applied to conventional licensed-production programs was completely inappropriate and unacceptable to JDA.

Pentagon negotiators countered that extensive incorporation of Japanese technology into the FS-X would significantly increase the cost of the fighter and violated the basic U.S. rationales for the program as a means of reducing development costs and achieving standardization and interoperability. JDA officials replied that the superiority of certain Japanese technologies and subsystems justified their use in many instances in place of American counterparts, a central argument the *kokusanka* supporters had been advancing since at least 1985 in support of indigenous fighter development.

As one JDA official was quoted at the time, "American technologies aren't the best in all situations." (Lachica, 1987b.) Another Japanese negotiator reportedly told a member of the U.S. team: The "only thing we need to buy from you is part of the engine and the ejection seat. Everything else we can do ourselves."²³

The U.S. side escalated the dispute by attacking the basic concept of Japanese indigenous technology. The DoD team argued that a strong case could be made that even the four major Japanese indigenous avionics systems were really derived from American technology.²⁴ From what the Americans knew of the Japanese programs, the only one of these systems that appeared to be based on an extensive domestic R&D effort was MELCO's APA radar. Yet even in this case, the argument could be made that MELCO had learned much and derived considerable knowledge of advanced radar technology through the licensed production of the Hughes APG-63 fire-control radar for the F-15 and other U.S. licensed-production programs. Westinghouse, of course, had a long and well-established relationship with MELCO. DoD had learned virtually nothing about the other three avionics systems, but it appeared that they were in very early stages of development and that JDA had not even selected prime contractors. However, Pentagon officials knew that Japanese firms had never before indigenously developed similar advanced military avionics. Furthermore, they knew that Toshiba was license-producing the Litton AN/ASN-109 INS and that JAEI manufactured Honeywell computers under license, both for the F-15 (GAO, 1982, Appendix II). They were aware that, on the F-4E*Jkai* program, Mitsubishi had teamed with IBM for the mission computer and that Toshiba again linked up with Litton for the INS. Although little was known about MHI composite wing technology, some U.S. officials also suspected the company had acquired considerable composites technology and know-how both from the F-15 program and from collaboration with Boeing on commercial airliners. Thus, it was not wholly unreasonable to argue that "indigenous" Japanese avionics systems and other technologies for the FS-X would undoubtedly draw heavily on the insights and technology acquired through military licensed-

²³Quoted in Tolchin and Tolchin (1992), p. 97.

²⁴Interview with a DTSA official, August 7, 1992.

production programs and other collaboration with American companies.

The Problem of U.S. Participation on Development of the Wing

The Japanese rejected these arguments out of hand. However, the FS-X wing problem in particular continued to worsen and eventually became the primary symbolic issue in the dispute over U.S. access to quality workshare and the question of technology reciprocity during the negotiations.²⁵ This was the only significant area of R&D work and technology in which American industry had so far expressed serious interest. Furthermore, U.S. Air Force technical experts had also identified it as potentially the most important area to target for technology flowback. And here the dispute went far beyond the question of labeling the technology "derived" or "indigenous" for purposes of access. As indicated earlier, GD's interests centered on the actual manufacturing process and tooling, rather than the underlying technology involved. Guaranteed U.S. access to data packages after the wing had been developed and manufactured by the Japanese was not viewed by the U.S. side as an effective or reliable means of learning and transferring the manufacturing know-how. Thus, GD insisted on full participation in actually designing, developing, and manufacturing the wing and its production tooling. In short, participation on the MHI wing became more a question of access to quality workshare for GD, as well as an issue of program oversight and control for DoD, than merely a symbolic political gesture of technology reciprocity. Nonetheless, the issue was argued largely in terms of technology access and flowback.²⁶

The Japanese adamantly opposed GD participation on the wing. In the first place, they insisted the wing represented fully indigenous technology and thus was subject to established JMTC procedures or to other flowback provisions applicable to nonderived technology. Second, MHI eventually argued that it had developed much of the wing technology from its own company-funded commercial efforts. Thus, it insisted that JDA did not have the right or

²⁵Interview with a senior DSAA official, August 6, 1992; Noble, n.d., p. 22.

²⁶Interview with a senior U.S. industry official, August 4, 1992.

authority to guarantee transfer of the wing technology, because MHI, not JDA, developed and owned it. The Japanese also expressed concerns about the added program costs and complexity of splitting up development and manufacture of a relatively small number of wing sets between two companies on opposite sides of the Pacific. Perhaps most important, the *kokusanka* supporters viewed the domestic wing development effort as an R&D program of critical national importance in Japan's quest for aerospace technology leadership and independence. It should not be shared or diluted by bringing in the American company.

The Illusion of a Compromise "Working Agreement"

Once again, however, mounting congressional pressure emanating primarily from the SASC led the Japanese to retreat several steps on the general issue of technology flowback and, more importantly, on GD participation on the wing. However, the U.S. side also compromised. Negotiators hammered out a "working agreement" on these issues in late May after weeks of intensive negotiations. JDA accepted the incorporation of the standard wording on free flowback of improvements "substantially derived" from U.S. technology in the draft MoU. However, the American team apparently dropped any explicit wording requiring *automatic* flowback. This change of wording would later be regretted by some on the American side. Furthermore, the U.S. officially recognized that the FS-X would also incorporate significant amounts of Japanese indigenous technology, most importantly the four avionics systems, that would not be covered by this provision. In return for this concession, the Pentagon succeeded in gaining Japanese acquiescence in principle to a program mechanism permitting significant U.S. control over the classification of technologies as derived or indigenous, excluding the four Japanese-developed avionics systems. U.S. requests for technical data on the four avionics systems and any other technologies not classified as derived would go through the JMTC process, in accordance with procedures established in the "Detailed Arrangements" signed in 1985. U.S. companies or the government would still have to negotiate the terms of transfer

and the cost with JDA or the corporate owner for each request for indigenous technology.²⁷

Like so many aspects of the MoU, this compromise was achieved essentially by leaving the final resolution of these most difficult and sensitive questions until later after the program was under way. The U.S. negotiators placed their faith in the ability of the TSC to influence and control the actual implementation of the program. Classification of technologies as derived or indigenous, of course, carried major implications for the cost of acquiring the technology and the ease of U.S. access. If classified as derived, technology had to be made available at no cost to the United States. If classified as indigenous or nonderived, the American side would have to pay for the technology. Furthermore, U.S. access could be held hostage to the slow and complicated JMTC review process, which permitted vetoes by either JDA, TRDI, or MITI and which so far had not proven very fruitful.

But U.S. access to Japanese technology was not the primary concern of U.S. negotiators. More important was U.S. influence over the development and production of the FS-X exercised through significant U.S. government and industry participation on the program. Having achieved this objective, many on the U.S. side assumed Japanese changes to the baseline F-16 would remain relatively modest. Thus, it appeared that virtually all the technology associated with the FS-X would ultimately remain classified as derived—with the exception of the four major avionics systems—thus making concerns over the JMTC process essentially irrelevant.²⁸

On the one area related to this debate over technology classification that DoD cared about the most—the composite wing—U.S. negotiators won a dramatic victory. The two sides eventually agreed in effect to treat the wing as if it were derived technology, thus requiring free flowback of all technology associated with wing development to GD. More important, JDA accepted GD's demand in principle for participation on the design and development of the wing. This concession may have been won in part by DoD's implied threat to appeal the "indigenous" status of the Japanese avionics systems and its willingness to continue to exclude them from the

²⁷Interview with a former DSAA official, August 7, 1992.

²⁸Interviews with a senior DSAA official, August 6, 1992, and a former DSAA official, August 7, 1992.

flowback provisions applied to derived technology in return for GD participation on the wing. Indeed, at the time, many U.S. sources still considered most of the Japanese indigenous systems and other "shared improvements" planned to the baseline F-16 to be "chiefly derived from technology originating in the U.S."²⁹

At the beginning of June, the new Secretary of Defense, Frank Carlucci, who had replaced Weinberger early in the year, led a Pentagon delegation to Japan to discuss mutual security issues, including the FS-X, with JDA Director General Tsutomu Kawara. Press accounts optimistically reported that all outstanding FS-X issues had been resolved and that the final government-level agreement would be signed during the visit.³⁰ The two sides did conditionally approve the general principles of the working agreement during this visit, but did not actually sign the final MoU.

Nonetheless, the American negotiators believed they had won a major victory. They had held firm throughout the negotiations on their two most important priorities—government oversight and substantial U.S. R&D workshare—and had achieved satisfactory results. U.S. representatives would hold a coequal position in the government oversight authority, the TSC. DoD had won a guaranteed 35 to 45 percent of R&D work for U.S. companies and, more important, GD involvement in wing development. A similar percentage share of production work seemed ensured by U.S. control over future engine production. Finally, the Japanese appeared to have finally acquiesced to the essence of the U.S. position on free flowback of derived technology, while accepting U.S. demands for significant influence over the categorization of any additional technologies beyond the four avionics systems as indigenous.³¹

THE JAPANESE BACKPEDAL

Unfortunately, American elation with the apparently successful outcome of the negotiations proved premature. While Director

²⁹"FSX Agreement to be Signed in Japan Today; Issues Resolved" (1988), p. 347.

³⁰"FSX Agreement to be Signed in Japan Today; Issues Resolved" (1988).

³¹"FSX Agreement to be Signed in Japan Today; Issues Resolved" (1988), and interviews with a senior DSAA official, August 6, 1992, and a former DSAA official, August 7, 1992.

General Kawara had apparently agreed to the general principles to be included in the MoU, the details of the working agreement still had to be approved by various offices in the Defense Agency, the Ministry of Foreign Affairs, MITI, and elsewhere in the government. The draft document soon generated considerable opposition from a variety of quarters within the government. Furthermore, the negotiations between GD and MHI to work out the details of U.S. participation on the wing development remained completely deadlocked. For the next six months, the Japanese delayed signing any final agreement. The key stumbling block was once again the issue of technology flowback, with MOFA leading the opposition in the Japanese government.³²

The draft MoU wording relating to free flowback of derived technology, and the question of which technologies to classify as derived, remained by far the most troublesome area during this second six-month period.³³ The Japanese strongly opposed the proposed wording permitting transfer to third parties of derived technology that had been flowed back to the U.S. government. Essentially, they argued that such technology should be limited exclusively to DoD use for direct U.S. defense purposes.³⁴

It is unclear why the Japanese objected so vociferously to these components of the draft MoU after appearing to be willing to accept the document in June. Apparently, a wide variety of concerns emerged on closer examination of the draft by various agencies and ministries not directly involved with the negotiations. Many of these concerns undoubtedly mirrored the same sorts of domestic political and commercial sensitivities widely expressed during the early 1980s when DoD officials were attempting to negotiate the broad generic framework agreements for the transfer of Japanese defense-related technology to the United States. Among the most sensitive was the issue of third-party transfer. Apparently, elements at both MOFA and MITI argued this provision violated the Japanese prohibition against military technology exports to virtually all countries with the exception of the United States.³⁵ Unlike earlier MoUs, Japanese officials now realized that DoD was taking

³²Interview with a senior DSAA official, August 6, 1992.

³³"U.S. Technological Lead at Risk" (1988).

³⁴Interview with a senior DSAA official, August 6, 1992.

³⁵See "Diet to Vigorously Scrutinize FSX Accord" (1988).

this provision much more seriously—at least in part because of the mounting pressure from Congress—and might actually actively seek flowback of derived technology. Furthermore, the U.S. side was clearly determined to gain GD involvement in the wing and treat all the technology related to it essentially as derived for purposes of free flowback, even though the Japanese considered it fully indigenous.³⁶ It also seems apparent that the *kokusanka* advocates attempted to exploit these concerns originating from elsewhere in the government to help undermine those components of the draft MoU that they perceived as inhibiting the independence of action during R&D needed to attain their long-term objectives.

In a frustrating repetition of the main dispute that had bogged down the negotiations prior to the June Carlucci-Kawara meeting, the negotiations over workshare on the wing soon emerged again as the single most intractable problem, primarily at the prompting of Congress. As other Japanese government agencies began registering their opposition to the working agreement in early July, a joint conference of the House and Senate settled on new language for the Senate amendment to fiscal year 1989 defense budget authorization legislation first proposed in the spring and aimed at limiting offsets on weapon collaboration programs. The new language directed the president to enter into negotiations with collaboration partners explicitly for the purpose of mitigating adverse effects on the U.S. defense industrial base of such agreements. In a dramatic modification of existing policy, the wording required the Secretary of Defense to consult closely with the Secretary of Commerce on the industrial impacts of collaboration agreements and “in making a determination on the validity of a protest by the defense industry regarding a memorandum of understanding.”³⁷ With the presidential election campaign in full swing, government officials were particularly sensitive to such congressional directives so closely linked to issues of jobs and industrial competitiveness. Furthermore, GD representatives had made little progress at this time in their discussions with MHI regarding actual involvement

³⁶At this point, Pentagon negotiators sought only to guarantee transfer of the wing technology free of cost to the United States. Only as a result of latter negotiations was the wing formally treated as de facto derived technology.

³⁷Quoted in “President Directed to Develop Defense Offset Policy” (1988).

on the wing. It became increasingly clear to DoD negotiators that the MoU would face political difficulties on Capitol Hill unless a specific mechanism was included in the agreement that ensured full involvement and access by GD to all aspects of design, development, and production of the wing during the R&D program.³⁸

Throughout the summer and fall, DoD struggled with the Japanese over the wing problem, as well as over other details of the agreement.³⁹ Because of GD's insistence that it had to be deeply involved in the entire R&D process for the wing to gain the full benefit of the technology, the Pentagon insisted that the MoU explicitly assign development and fabrication of entire wings to the U.S. contractor.⁴⁰ In addition, at least some officials at the Pentagon and GD wanted to exercise strong influence over the final design and configuration of the wing so that it could be applied to the F-16 Agile Falcon modification program, in which the Europeans were showing increasing interest.⁴¹

The Japanese continued to protest vigorously. The R&D program envisioned the manufacture of a total of only six wing sets: four for a like number of prototype fighters to be used in the flight-test program and two for static ground testing. Dividing up the development and production of six wing sets between two firms on opposite sides of the Pacific, which required the duplication of personnel and extremely expensive specialized tooling equipment, appeared to the Japanese, with some justification, to be enormously inefficient and unnecessarily costly (Chinworth, 1992, p. 148; Wanner, 1988, pp. 9-10).

³⁸Wanner (1988), p. 9; interview with a senior DSAA official, August 6, 1992.

³⁹See "FS-X Delays" (1988). Another major dispute that proved difficult to resolve concerned the dollar/yen exchange rate to use on the program, which would determine the actual dollar amount received by U.S. contractors. The Japanese insisted on ¥150 to the dollar, compared to the U.S. position of ¥120. The two sides eventually settled on ¥130 to the dollar. Interview with a senior DSAA official, August 6, 1992.

⁴⁰One U.S. participant recalls that the initial Pentagon position called for U.S. manufacture of all the prototype wings for one side of the aircraft. Presumably this would help hold down costs by avoiding the necessity of duplicating tooling in both countries for both the left and right wings. Letter to the author from a U.S. Air Force officer, August 9, 1992.

⁴¹"Japan, U.S. Sign Pact to Develop FS-X Fighter" (1988), p. 25.

THE JAPANESE YIELD TO U.S. PRESSURE

A major break in the deadlock finally came late in the year. Subjected to political pressure from the United States and eager to get the program officially funded and under way, the Japanese finally gave way and accepted the U.S. wording on derived technology flowback. As mentioned earlier, however, the explicit requirement for *automatic* flowback had been dropped.⁴² To permit a timely signing of the overall program MoU, negotiators decided to leave the difficult wing issue unresolved for the time being. Both sides accepted the principle of full GD participation in wing development but left the details of how that was to be accomplished to further negotiation. These compromises opened the way for the formal signing of the FS-X cooperation agreement. On November 29, Ambassador Mike Mansfield and Foreign Minister Sosuke Uno signed the overall cooperation document. The same day, representatives from DSAA and the JDA Equipment Bureau signed the detailed MoU. From the U.S. perspective, the six-month delay had accomplished nothing for the Japanese: The document differed little from the draft MoU proposed by DoD and provisionally approved during the Carlucci-Kawara meetings in June.⁴³

Within weeks, several more key details were ironed out. In late December, MHI gave in and agreed to permit GD to manufacture two of the six wing sets. On January 10, 1989, the two firms signed the LTAA that awarded GD development and manufacture in the United States of two wing sets. GD also won the development work on the aft fuselage and involvement in developing the FBW flight-control system and computer software, as well as overall system integration (Mecham, 1989).

Pentagon and industry negotiators had taken great care to make sure that both the U.S. and Japanese wings would be manufactured to the same standards and designs. Thus, one GD wing set was designated to be installed on one of the prototypes for use in the flight-test program, and the other wing set was reserved for one of the two airframes scheduled for ground-based fatigue and durability testing.⁴⁴ The two firms pledged to use identical de-

⁴²"FS-X Memo Signed" (1988).

⁴³"Diet to Vigorously Scrutinize FSX Accord" (1988), pp. 2-3.

⁴⁴"FSX Agreement Gives GD Two Wing Sets" (1989).

signs, materials, tooling, manufacturing processes, and so forth. To ensure technology transfer and conformity of approach, the two companies agreed to exchange engineers working on the wing.⁴⁵

In early January, industry and government negotiators also definitively settled on a final figure of approximately 40 percent of the R&D budget as the overall workshare awarded to U.S. industry.⁴⁶ JDA planned a development budget of ¥165 billion. At the negotiated exchange rate of ¥130 to the dollar, this gave U.S. industry about \$500 million of work out of a total budget of \$1.27 billion.⁴⁷ The Japanese envisioned a production run of 130 to 170 aircraft, at a total cost of around \$7 billion. Although the MoU still lacked a specific production percentage reserved for U.S. companies, Pentagon officials remained confident that U.S. control over the engine would guarantee American industry something approximating 40 percent of the production work, worth about \$2.8 billion.⁴⁸

Thus, after more than a year of intense negotiations over the MoU and associated details, which had followed the earlier years of tough negotiations over the very principle of collaboration, dating back to mid-1985, the FS-X dispute appeared finally resolved in a manner highly favorable to U.S. interests. The road now seemed open for both sides to leave behind the years of sometimes acrimonious negotiations and get down to work on the first large-scale cooperative military R&D program ever conducted by the two countries. Indeed, JDA and DoD negotiators had already agreed that detailed design work could begin as early as March 1989. Pentagon officials held out high hopes that FS-X would ultimately serve as a model for an increasing number of mutually beneficial collaboration programs with Japan for the development of other military equipment.⁴⁹

⁴⁵"Accord Reached on FS-X Development Project" (1989). According to U.S. industry officials, the industry-level agreements also contained less-restrictive provisions than the government-level MoU for U.S. access to all technologies incorporated into FS-X.

⁴⁶"Accord Reached on FS-X Development Project" (1989).

⁴⁷"Japan, U.S. Sign Pact to Develop FS-X Fighter" (1988).

⁴⁸"FSX Agreement Gives GD Two Wing Sets" (1989).

⁴⁹"Design Work On FSX to Begin in March" (1988).

But this outcome was not to be. Unknown to the U.S. negotiators who signed the MoU and worked out the final details in January 1989, the FS-X issue would explode a few short weeks later into a political firestorm that would lead to one of the most vitriolic public disputes between the United States and Japan since the Second World War. Furthermore, as the contractors and working-level officials sat down to actually begin implementing the program, it soon became clear that many of the disputes that negotiators had wrestled with for years and believed had finally been settled had merely shifted once again to a new arena.

The storm that was about to break in Congress might have been better foreseen by the DoD negotiators. When the program framework discussions had begun in late 1987, technology access issues had been a relatively low priority for the U.S. side. By the time the MoU had finally been signed, questions of technology access and transfer had emerged as the most contentious and difficult issues confronting both sides. This change had been mainly brought about by political pressures from Congress on the U.S. negotiators. These pressures would soon burst out into the open in a frontal attack on the agreement that would eventually transform the program and indirectly assist the strategy pursued by the *kokusanka* supporters.

THE STORM BREAKS IN CONGRESS

**A POLITICAL-MILITARY AGREEMENT ATTACKED
ON ECONOMIC GROUNDS**

In the minds of the Pentagon negotiators, the FS-X agreements signed in November 1988 and January 1989 firmly established the most important principles the United States government had been seeking to govern the program. First and foremost, they required the formation of a joint oversight body, the TSC, that provided the Pentagon and U.S. Air Force representatives a forum to influence the evolution of the program. Secondly, they strongly affirmed the principle of full U.S. industry involvement on all aspects of design, development, testing, and production, with special emphasis on the composite wing. Third, they endorsed the fundamental Pentagon objective of maintaining interoperability of the FS-X with existing and planned U.S. fighters.¹ These principles, it was believed, would provide sufficient Pentagon and industry supervision over the program to ensure that the FS-X would not be transformed into the Rising Sun fighter but rather would remain a relatively modestly modified F-16 whose development would contribute directly to enhancing the military capabilities of the combined U.S.-Japanese

¹The MoU emphasizes the importance of interoperability, but does not explicitly require maximum design and component commonality between the F-16 and FS-X. Furthermore, ultimate control over design configuration is vested in JDA. Nonetheless, most Pentagon officials believed that the extensive involvement of U.S. industry, Japanese industry's lack of experience in developing an advanced fighter, and cost considerations would all lead to a relatively modestly modified F-16 with considerable U.S. content.

military forces, and possibly to the broader Agile Falcon program and other general U.S. burden-sharing objectives.²

Furthermore, Pentagon officials believed the FS-X collaboration agreements adequately met the concerns that Congress had been voicing with increasing stridency regarding U.S. workshare and access to Japanese technology. They also were confident that existing DoD procedures would effectively control the transfer of sensitive U.S. technology to Japan. Despite tenacious Japanese opposition, the U.S. side had won nearly one-half of the total R&D work as a percentage of the development budget for U.S. industry and had reached an agreement in principle for a generally similar percentage of work during production. This had been achieved even though the U.S. government was not contributing a single penny to the R&D program, an unprecedented situation in the history of international cooperative military R&D. In addition, the Pentagon withheld release of the engine for licensed manufacture during the production stage as an ace in the hole to guarantee substantial U.S. workshare when the production MoU was negotiated. By insisting on and winning the right for GD to participate fully on the wing, the U.S. negotiators believed they had assured high-quality workshare for the American company in an area in which it was most interested. DoD had succeeded in incorporating its wording on free flowback of U.S.-derived technology into the MoU, even though the dispute over this issue had contributed to a delay in the negotiations of at least six months. And finally, the right of U.S. access to Japanese technology had been confirmed. Considering that in 1985 prior to DoD intervention, the Japanese had been on the verge of launching fully indigenous fighter development with no major American work participation or program control, DoD negotiators believed they had achieved a significant victory.³

However, contrary to Pentagon expectations, the most difficult battles over FS-X had not yet even begun. Despite the general satisfaction of the DoD team with the agreements, influential circles within the Executive Branch and Congress remained profoundly

²Interview with a senior DSAA official, August 6, 1992. Also see "Japan, U.S. Sign Pact to Develop FS-X Fighter" (1988); "FS-X Memo Signed" (1988).

³"Japan, U.S. Sign Pact to Develop FS-X Fighter" (1988); "FS-X Memo Signed" (1988); Tolchin and Tolchin, 1992, p. 97.

troubled with the outcome of the negotiations, particularly in the areas of workshare and technology transfer. These individuals would soon ignite a bitter public debate that would shake the very foundations of the U.S.-Japan security relationship. The underlying issues, of course, were the same ones that had bedeviled the U.S.-Japan relationship in defense technology and military equipment collaboration since the late 1970s: the persistent trade deficit with Japan and the desire to preserve American jobs in high-technology industry and U.S. industrial competitiveness in the face of the relentless Japanese economic challenge.

It is a great irony that DoD's apparent success in achieving its most important objective—stopping indigenous development by winning Japanese acceptance of an FS-X based on the F-16/Agile Falcon design—ultimately served to provoke the enormous explosion of criticism from Congress against the FS-X agreement. By successfully forcing a jointly modified F-16 on the Japanese and by attempting to maximize U.S. industry involvement in R&D while minimizing changes to the baseline U.S. fighter, the Pentagon strategy raised again in the minds of many members of Congress the specter of huge transfers of advanced U.S. aerospace technology to America's most fearsome economic competitor. Had DoD failed in its objective and had Japan gone ahead with indigenous development, the persistent trade imbalance and the issue of jobs would have been raised in criticism of the outcome, but technology transfer and reciprocity would not. By winning a compromise that it perceived as highly favorable to U.S. security and industry interests, the Pentagon opened itself to attacks on both counts: (1) jobs and workshare and (2) technology transfer and reciprocity.

In the heat of the ensuing public debate that erupted in early 1989 and raged well into the summer, a central Pentagon objective—preventing the *kokusanka* supporters from moving Japan toward a more autonomous defense industrial base and potentially greater freedom of action in its security policies—was generally lost in the outcry over jobs and alleged technology giveaways. Defenders of the FS-X accords had to respond to their critics with their own counterarguments stressing the technological and economic benefits that would accrue to the United States from the program. This put them at a significant disadvantage, because such benefits had never been the primary concerns of the Pentagon negotiators. Further undermining their position, they felt con-

strained from publicly advancing their more important security concerns in plain terms, for fear of offending the Japanese. Instead, they felt compelled to argue in bland generalities of the need for "preservation of the political relationship" and "enhancing security ties" between the two countries (Chinworth, 1992, p. 149).

But the congressional debate would remain overwhelmingly focused on economic issues, especially technology transfer and workshare. As a result, FS-X proponents were forced to emphasize the purported benefits of both flowback and access to Japanese indigenous military technology far beyond their original intent and to defend the economic benefits of workshare that had been fought over and won at least in part for noneconomic reasons. By the final resolution of the immediate controversy in September, the question of access to Japanese technology—most importantly the APA radar and the composite wing—had been elevated to a central defining issue in the public debate over the relative merits and net benefits of the program.

Technology reciprocity, as represented by access to indigenous Japanese technology, rose to such primary importance because, in essence, all the congressional opposition flowed from one simple fear: that the FS-X program would transfer advanced American aerospace technology that would add significantly to Japan's ability to build a formidable commercial aerospace industry that would directly compete against the United States. Trade hawks viewed aerospace as the last bastion of unchallenged American industrial and technological preeminence in the global marketplace. Their nightmare was the emergence of an aggressive commercial aerospace industry in Japan that would repeat the successes of the Japanese auto and consumer electronics industries against their American competition.

At the heart of the debate were differing views of the net balance between the jobs, money, and technology America could acquire from the program and the long-term cost to U.S. industry in terms of future competition resulting from the transfer of technology and know-how to Japan. Opponents of the FS-X agreement wanted ironclad assurances that the most sensitive F-16 technologies with the greatest potential commercial applications—particularly system integration know-how, certain engine technologies, and the source codes for the flight control and mission computer software—would not be transferred to Japanese industries. Fur-

thermore, they demanded that, in addition to quality workshare and license fees, American industry receive advanced Japanese technologies to compensate at least in part for the transfer of U.S. aerospace technology to Japan. They were convinced that the agreement as it stood did not provide adequate safeguards and guarantees on these issues and that the technology transfer balance favored Japan.

Pentagon supporters of the program believed that the potential commercial value of the F-16 technology that would be transferred to Japan was being grossly exaggerated. Although nearly every independent technological assessment of the program confirmed this view by showing that F-16 technology had little direct commercial application, the highly charged and emotional atmosphere surrounding the debate made it difficult to convince critics of the program. Most FS-X critics failed to understand a basic reality of technology transfer: Technical data packages that exclude key developmental information only transfer the "know-how" and not the "know-why" to foreign industry. Thus, the *more* U.S. data transferred to Japanese industry, the *less* Japan would actually learn about the complex and difficult *process* of developing a new world-class fighter.

In the end, the opponents of the FS-X program as negotiated by the Pentagon undermined their own objectives in at least two ways. First, by focusing on allegations of a technology giveaway, they succeeded in placing additional restrictions on the transfer of U.S. technology, which ultimately led to greater Japanese indigenous R&D. Secondly, by vastly increasing the relative political importance of technology reciprocity and other economic issues, opponents of the program diverted U.S. attention from the *kokusanka* strategy of maximizing modifications and applications of new Japanese technology to the F-16/SX-3 design concept.

ORIGINS OF THE ATTACK ON THE PENTAGON'S FS-X AGREEMENT

The immediate origins of the public controversy over FS-X can be traced to the enactment of the fiscal year 1989 Defense Authorization Act in late September 1988 (see Chapter Seven) and Pentagon briefings on the completed FS-X MoU presented to DoC officials and Capitol Hill staffers late in the year. In its final form, the

fiscal year 1989 defense budget legislation had included language requiring DoD to consider, in close consultation with the Secretary of Commerce, the effects on the U.S. industrial base of MoUs negotiated for collaborative equipment programs. Since DoD had essentially completed negotiations on the FS-X MoU when Congress passed this legislation, Pentagon officials merely briefed the results to DoC personnel in late October. However, the Pentagon resisted transferring a copy of the MoU to DoC until well into December (House, 1990a, p. 43).⁴ That same month, DoD officials briefed key congressional staff members, many of whom had been following the MoU negotiations closely since the previous spring and had been involved in drafting the new legislation requiring DoD consultation with the DoC. Some of these staffers represented the Senate Foreign Relations Committee, which ultimately had to approve the FS-X MoU, and interested senators, such as Jeff Bingaman, Alan Dixon (D-IL), and John Heinz (D-PA) (Tolchin and Tolchin, 1992, pp. 99–100).

A small but committed group of these DoC and congressional staff members came away from the DoD briefings both dissatisfied with the MoU provisions about technology transfer and workshare and angry about what they considered the cavalier treatment of their concerns by the Pentagon and the disregard of the recently passed legislation requiring Pentagon consultation with DoC. Their fundamental concerns focused on the need for greater technology reciprocity and workshare as compensation for the transfer of valuable U.S. technology to Japan. As one DoC official put it,

We are concerned that they develop an industry that is purely based on U.S. technology that's been transferred without receipt of benefit of that transfer of technology. That means either significant reimbursement for it, or a opportunity to share in any technology improvements that are provided in Japan.⁵

With the transition to the new Bush administration just getting under way, FS-X opponents had a ready-made forum to raise their concerns in the numerous confirmation hearings for new

⁴DoD had classified the MoU secret at the insistence of the Japanese government in deference to its concerns over domestic Japanese political sensitivities to military collaboration with the United States.

⁵John Richards, quoted in Tolchin and Tolchin (1992), p. 101.

high-level administration officials. Various senators advanced these concerns during the confirmation hearings in January for Robert Mosbacher, President Bush's appointee for Secretary of Commerce. Senator Jesse Helms (R-NC) also pressed these issues during James Baker's confirmation hearings for Secretary of State, suggesting that the new administration should take a second look at the FS-X MoU before submitting it to Congress for approval.⁶ Senator Bingaman did likewise with the Secretary of Defense designate, John Tower. Carla Hills, the new administration's appointee for U.S. Trade Representative (USTR), also was closely questioned on FS-X. Both Bingaman and Senator Dixon then publicly announced outright opposition to the FS-X deal.

However, it took a highly critical article entitled "Giving Japan a Handout: Why Fork Over \$7 Billion in Aircraft Technology?" written by Clyde Prestowitz, a former Reagan administration trade negotiator, and published on January 29 in the *Washington Post* (Prestowitz, 1989b), to galvanize the opposition and help transform the FS-X deal into the most hotly debated and controversial public issue facing the new administration.⁷ This article laid out the basic parameters and issues of the public debate that would remain remarkably constant over many months to come. The first paragraph succinctly summarizes the fundamental concerns of the FS-X opponents:

First it was TV sets, then VCRs, then semiconductors. Now, unless Congress and the administration act quickly, the United States will shortly give Japan a big boost toward its long-sought goal: leadership in aircraft manufacture, one of the last areas of American high-technology dominance [FS-X] will transfer technology developed at great expense to U.S. taxpayers at very low cost to a country whose primary interest is not defense but catching up with America in aircraft and other high-technology industries.

⁶"FSX Issues Surface in Congress" (1989).

⁷Prestowitz was the author of the well-publicized and controversial book *Trading Places: How We Are Giving Our Future to Japan and How to Reclaim It* (Prestowitz, 1989a). Later versions of this book included considerable discussion and criticism of the FS-X negotiations.

Prestowitz's article attacked the concept of technology reciprocity as established in the MoU as a means of compensating for the transfer of U.S. technology to Japan. He pointed out that an important justification for the agreement used by its supporters was that FS-X would "give us access to advanced Japanese technology and develop cooperative industrial relationships that will ensure continuing access and cost-sharing in the future." He disputed this argument, claiming that "there is serious doubt as to whether the advertised Japanese technology is genuinely advanced—and whether GD will get it if it is." These questions over the value of, and likelihood of access to, Japanese technologies soon became a primary focus of the debate.

The Prestowitz article received widespread attention inside the Beltway, helping to spur the congressional opposition into action. On January 31, a group of eleven prominent senators, led by Jesse Helms and Jeff Bingaman, wrote President Bush requesting a delay in the submission of the FS-X MoU to Congress for approval so that it could be thoroughly reviewed in light of their concerns by the Departments of Commerce and Energy, the USTR, and the Office of the White House Science Advisor, as well as the Departments of State and Defense.⁸ A little over a week later, 21 senators, led by Alan Dixon, sponsored a formal resolution calling for a 60-day review of the agreement by all concerned government agencies. Twenty-four representatives, led by Mel Levine (D-CA), followed a few days later with a letter to the President threatening to introduce legislation in the House blocking the FS-X deal unless the agreement was modified (House, 1990a, p. 42).

Backed by this opposition from Congress, certain government officials within the new administration, led by Secretary of Commerce Mosbacher, began pushing hard for a 60- to 90-day delay of the submission of the agreement for congressional approval, to permit an extensive interdepartmental review of its long-term effects on the U.S. industrial base. Mosbacher insisted on a prominent DoC role in the proposed review, based on the new wording in the FY 1989 Defense Authorization Act. DoD and the Department of State opposed a coequal role for DoC and insisted that any re-

⁸Once the Executive Branch submits an arms deal or weapon collaboration agreement, Congress has 30 days to review it or try to block it before it goes into effect.

view had to be concluded much more quickly to permit the Japanese government to authorize a start-up contract for MHI and the other FS-X contractors prior to its fiscal year budget deadline of March 31. However, the Pentagon had difficulty countering the DoC because the Tower nomination was in serious trouble on the Hill, leaving DoD without a leader. Furthermore, Mosbacher, a close friend of President Bush, used his special relationship and access to great effect. Wishing to avoid a major conflict with Congress at the very beginning of his term, President Bush agreed to permit the review. At a hastily convened meeting of the National Security Council (NSC) on the evening of February 14, Mosbacher won the right to oversee an interdepartmental review with the Pentagon. However, the NSC limited the review to only about three weeks, with a due date of March 10, in deference to the requirements of the Japanese budget cycle (Rosenthal, 1989).

PRODUCTION WORKSHARE AND THE TWO-WAY TRANSFER OF TECHNOLOGY

By this time in mid-February, the dispute could be boiled down to contrasting views over the answers to two basic questions:

1. What was the true value to Japanese industry of the F-16 technology proposed for transfer?
2. What was the actual value of the benefits in terms of license fees, workshare, and Japanese technology—particularly the wing and radar—that would likely flow back to U.S. industry in return, and how likely was it that U.S. industry would really get the technology?

Many in Congress and the DoC suspected the answers to both questions added up to a substantial net loss over the long term for American industry.

The simplest and most straightforward objection voiced by opponents regarded the lack of specific workshare guarantees for U.S. industry during the production phase of the program. Program defenders pointed out that negotiators for both countries had reached an understanding that U.S. production workshare would approximate the 35 to 45 percent workshare for R&D and that greater

specificity was not possible, given the contracting regulations and procedures of the Japanese government. Nonetheless, opponents expressed outrage over the vagueness of the wording of the MoU on this subject as leaked to the press: "Japan agrees to provide the U.S. industry with a share of production work based on its experience in the development phase and the easiness of the operation and maintenance of the aircraft in Japan."⁹ As an aide to Senator Bingaman commented, "That's an out for [the Japanese] to say GD won't be compatible with Japan's production." (Mecham, 1989.)

Another criticism of the workshare agreement focused on an alleged gross understatement by the Japanese of the total cost of R&D, which could in effect greatly reduce actual U.S. workshare in both R&D and production. DoD officials expressed considerable skepticism during the original MoU negotiations over Japanese estimates of total R&D costs. As Prestowitz and others claimed later, "both Japanese and American analysts believe [the R&D] budget to be underestimated by half or more. Thus GD's share may be less than 20 percent" of the actual R&D program costs (Prestowitz, 1989b).

By this time, however, technology reciprocity had become a central focus of the dispute, both inside the government and in Congress. As one Pentagon official summarized the problem, "The details have to be spelled out in terms of how much [technology] flows out and how much comes back."¹⁰ The debate over technology reciprocity had two primary components. The first concerned the value and the commercial applicability of the U.S. F-16 technology and data that would be transferred to Japan, with particular emphasis on source codes for computer software, system integration know-how, and engine technologies. The second revolved around the relative value of Japanese-developed technologies for U.S. industry and the likelihood of access to them. Here, the de-

⁹Quoted in Mecham (1989). This sentence, taken out of context from the classified "Agreed Minute" and leaked to the press, was widely reproduced at the time. However, this sentence is actually highly misleading because it is only a partial and incomplete quotation of the actual sentence in the official document. The full sentence clearly requires the U.S. share of production work to be comparable to the share of work won by U.S. industry during the R&D phase. Letter from a U.S. Air Force officer, August 10, 1993.

¹⁰Quoted in Mecham (1989), p. 16.

bate centered principally on MHI's cocured composite wing and on MELCO's APA radar.

Opponents of the agreement feared that the transfer of F-16 technology would help build a Japanese commercial aerospace industry and that this was the key motivation of the Japanese for involvement in the program. As one congressional aide put it, "The Japanese will use this agreement to suck out of our brains 70 years of aerospace learning."¹¹ FS-X supporters countered that the F-16 embodied "old" 1970s technology, that fighter technology had very little applicability to commercial aircraft development, and that the Pentagon had always planned to restrict and control technology transfer to Japan carefully. Opponents came back with the arguments that the U.S. fighter had been continually updated with new technology since it was first fielded and that Japanese industry would receive significant U.S. technology and assistance in the specific areas of its greatest weakness—particularly system integration, software development, and engine technologies—which would be useful in commercial aircraft development. Critics like Prestowitz noted that F-16 "technology is only old if you have it."¹²

Debating the Value of Access to Japanese Technology

Because of the enormous alleged commercial value of the F-16 technology expected to be transferred to Japan, FS-X supporters increasingly emphasized the importance to U.S. industry of the agreement's provisions for access to Japanese technology.¹³ Indeed, from very early in the debate, GD pressed this point vigorously, even making the rather extravagant claim early in the debate that the FS-X deal would permit access to "new Japanese technology *vital* to future military aircraft production."¹⁴

It is hardly surprising that advocates zeroed in on access to Japanese composite-wing technology as a key benefit of the program, because GD had expressed interest in this area since at least

¹¹Quoted in Stokes (1989).

¹²Quoted in Towell (1989).

¹³For example, see Carlucci (1989); Sieg (1989); "Management, Lead-Nation Reforms Seen for International Programs" (1989).

¹⁴"FS-X Gives U.S. 'Vital' Production Technology, GD Says" (1989). Italics added.

the second half of 1987. The origin of the newfound emphasis on APA radar technology is less immediately obvious. The report of the 1983 DSB Task Force had indicated that JDA was engaged in some "very ambitious programs [for] next-generation fighter avionics," and some members of the Pentagon's 1984 TAT had noted interesting developments in APA antenna arrays. T/R modules and active aperture systems had featured prominently in the TAT's list of notable Japanese designs included in its final report. Its list of important Japanese production technologies had been headed by broadband phased arrays (DoD, 1985; also see Chapter Two). But subsequent TAT visits had produced little useful information on the Japanese radar. Some additional information had been provided during the FS-X negotiations in 1986 and 1987 and during the Sullivan team visit to Japanese industry, but the details remained very sketchy. Furthermore, Westinghouse had apparently seen little of value for U.S. industry in the MELCO radar system when asked by DoD officials in late 1987 (see Chapter Seven).

Nonetheless, of the four indigenous avionics systems, the APA radar clearly stood out as the one of greatest potential interest to the Pentagon. This was in part because even less was known about the other three systems. But more important, there was indeed genuine Pentagon and U.S. industry interest in gaining more information about Japanese technological capabilities in certain specific areas of the MELCO radar, more than the overall system itself.¹⁵

As Westinghouse and Texas Instruments continued to develop their APA radar prototypes for future U.S. fighters, the high manufacturing costs for the T/R modules emerged as a significant problem. Each prototype antenna array employed about 2,000 T/R modules. The production cost for each module at this time was estimated at \$8,300 (fiscal year 1985 dollars), meaning that the total cost for each antenna array alone was about \$16.6 million. This was roughly the cost of an entire F-16 fighter at the time. Such costs clearly needed to be dramatically reduced to make APA fighter radars affordable. U.S. industry established an ultimate cost goal for T/R modules of \$400 apiece, but was far from achiev-

¹⁵One former program official explained to the author: "The DoD did not think the wing was enough so we started to play up the only thing which we knew anything about—the APA radar."

ing this objective. Government and industry contacts, and the strong reputation of the Japanese electronics industry, had led Pentagon experts to believe that Japanese firms had the potential capability to manufacture T/R modules at a considerably lower cost than U.S. contractors (GAO, 1990, pp. 28–29).

Japanese industry's extensive experience in the commercialization and mass production of components important for APA radar, such as GaAs FETs and a variety of MMIC devices, as observed during TAT visits seemed to support this view. The design, packaging, and miniaturization of Japanese T/R modules also appeared potentially useful. Thus, while most U.S. defense electronics contractors believed overall Japanese radar system technology lagged far behind that of the United States, some felt that MELCO's manufacturing and process technology, particularly for T/R modules, could be of great benefit to the United States in reducing U.S. APA radar antenna array costs. But the subtleties of this argument were often lost in the heat of the public debate over FS-X, as advocates on both sides often debated the value of the radar system itself (GAO, 1990, pp. 28–29).

In response to this increased emphasis by advocates on the benefits of access to Japanese composite wing, radar, and other technologies, FS-X opponents increasingly focused their criticism on the alleged value and likelihood of access to Japanese indigenous technologies. The agreement's detractors soon began insisting that U.S. defense contractors were far ahead of their Japanese counterparts in composite structures and military radars. Furthermore, they strongly questioned the prospects for genuine U.S. access, even if the technologies were of interest, based on the dismal record of past DoD attempts to gain access to Japanese technologies.

Commenting on MHI's composite wing, Congressman Mel Levine noted early in the debate that "it may be technology that [General Dynamics] doesn't have, but it's not technology that the American fighter aircraft industry doesn't have." (Towell, 1989, p. 535.) Many other critics insisted that Lockheed, Boeing, Grumman, Northrop, and McDonnell-Douglas all possessed composite-structure capabilities superior to those of both Japanese industry and GD. Indeed, some alleged that JDA selected GD over McDonnell-Douglas knowing that the former company's relative weakness in composites would make it more interested in coopera-

tive development and technology transfer to Japan.¹⁶ Critics also widely quoted the chief materials engineer at the U.S. Air Force materials lab at Wright-Patterson Air Force Base as saying (Stokes, 1989):

They don't have anything that we would really need. I don't see why we are going to trade fighter technology for technology that we can't use.

Opponents focused somewhat less attention on the APA radar, in part because so little was known about it. But many argued that U.S. radar contractors were the world's most experienced and that MELCO's radar was merely an experimental prototype that was far from demonstrating any real production cost savings. As President Reagan's former science advisor claimed, "We're developing new phased-array radars that are well in advance of what the Japanese are working on."¹⁷

Perhaps a more telling critique, however, of the claimed technology benefits that would flow back to U.S. industry from the APA radar and composite wing centered on the broader history of difficulties experienced for years in DoD's frustrating attempts to gain access to Japanese defense-related technologies. Opponents pointed out that the United States *already* had the right of access to the radar technologies without the FS-X agreement, based on the 1983 Exchange of Notes permitting transfer of Japanese technologies to the United States.¹⁸ But as Senator Bingaman and others argued, Japan had failed to live up to the spirit of the 1983 agreement. They maintained that by excluding dual-use technologies from the JMTC structure, the 1983 accords would permit MITI and Japanese industry to continue to block transfer of such technologies as GaAs MMIC and other dual-use FS-X technologies of interest to the Pentagon effectively, as they had consistently done in the past (Mecham, 1989).

¹⁶"FS-X Technology from Japan Wouldn't Be New to U.S., Opponent Says" (1989).

¹⁷Quoted in Tolchin and Tolchin (1992), p. 103.

¹⁸"FS-X Adversaries Dispute Japan's Motives, Benefits" (1989).

Supporters of the FS-X deal, such as James Auer,¹⁹ conceded that this had been a serious problem for some years but nonetheless portrayed FS-X as the first major benefit and test of the 1983 Exchange of Notes.²⁰ Others suggested that U.S. industry and the Pentagon had not tried hard enough to gain access to Japanese technology: "We haven't taken the issue very seriously on the American side." Another expert added that the 1983 agreement had not worked because "we haven't tried to make it work."²¹ Clearly, FS-X opponents in Congress and DoC were determined to win guarantees from the administration that the technology access agreement *would* be made to work this time and that the Pentagon would take the issue more seriously, if they were to give their support to the FS-X deal.

As the interagency review led jointly by the Pentagon and the DoC got under way with these arguments in the background, opponents of the deal in Congress and elsewhere began spelling out what kinds of specific changes they required. First and foremost, they insisted on much stricter limitations and controls on the U.S. technology that would be transferred to Japan. Opponents, such as Senator Dixon, wanted guarantees that the technology from the most recent versions of the F-16 would not be transferred. They demanded the government block the transfer of a variety of specific "sensitive" technologies, particularly those involving design methods, computer source codes, and engine technologies. Second, Dixon and others wanted "a bigger piece of the pie" for U.S. industry.²² Most important, they insisted on explicit guarantees of at least 40 percent of the production work—in addition to the 40 percent of R&D work—for U.S. contractors. In addition, DoC officials and a group of senators, led by Jesse Helms, demanded that Japan be required to purchase an initial batch of 50 to 60 F-16s off the shelf from GD. Finally, Senator Bingaman and other critics demanded that assurances and far more specificity be built into the

¹⁹Auer had left DoD with the outgoing Reagan administration, becoming Director of the Center for U.S.-Japan Studies and Cooperation at Vanderbilt University.

²⁰"FS-X Adversaries Dispute Japan's Motives, Benefits" (1989).

²¹Gregg Rubinstein and Richard Samuels, as quoted in Stokes (1989).

²²Quoted in Towell (1989), p. 537.

agreement for U.S. access to Japanese FS-X technologies, especially the wing and APA radar (Towell, 1989).

THE INTERAGENCY BATTLE: COMMERCE VERSUS DEFENSE

While generally hidden from public view, the behind-the-scenes battles over these issues that took place during the three-week crash interagency review became as fierce as those in Congress. Pentagon and DoC officials clashed repeatedly over most issues in contention. Heated disagreements continued through the final week of the review period prior to the due date established by the administration of Friday, March 10.

DoC officials strongly pressed four primary objectives: (1) institutionalization of DoC involvement in all future defense equipment collaboration programs; (2) establishment of a permanent role in the control of technology transfer to Japan on the FS-X program; (3) a specific statement of restrictions on what technologies would not be transferred; and (4) a dramatic strengthening of the guarantees of U.S. access to Japanese indigenous technologies (Farnsworth, 1989a).

Pentagon and Department of State officials opposed the overall DoC initiative largely because they believed the existing safeguards in the agreement on all these issues were adequate. But more important, they feared that Mosbacher's offensive would lead to demands for a renegotiation of the MoU, ultimately causing the Japanese to pull out of the deal. As one Pentagon official complained, "Mosbacher's objections [are playing] into the hands of the Japanese, who opposed the deal in the first place."²³ According to another Pentagon source, Mosbacher and his staff were "running amok" and did "not understand the issues" at stake.²⁴

Many Pentagon officials viewed the dispute primarily as a power play in a turf battle spearheaded by Mosbacher to win a greater role for the DoC at the expense of the traditional security establishment. But they also feared that in the process the FS-X deal, which had been so painstakingly crafted over three long years of difficult negotiations to prevent indigenous development, would

²³Quoted in Nordlinger (1989).

²⁴"FSX Formula Worked out Between U.S. and Japan" (1989).

be scuttled. DoD officials believed the *kokusanka* supporters would try to exploit the growing feelings of resentment and bewilderment in Japanese political circles in reaction to the DoC's demands for revisions to resurrect the option of indigenous development of the Rising Sun fighter. As Auer pointed out, "If I were a Japanese industrialist I would hope the FS-X deal does not go through."²⁵ But DoC and other opponents dismissed these concerns, seriously questioning the ability of Japanese industry to go it alone without significant U.S. assistance. Furthermore, they argued that the United States must reject the notion of "sacrificing economic competitiveness on the altar of a security relationship that is of questionable worth to America." (Sneider, 1989a.)

During the interagency review process, much of the debate revolved around a list of 20 commercially sensitive F-16 technology areas that the DoC had developed in conjunction with USTR and other agencies. The bulk of the list concerned leading-edge design and manufacturing processes. DoC officials wanted very strict controls applied to the transfer of these technologies to Japanese industry for use on the FS-X program. Led by DTSA officials, the Pentagon eventually demonstrated to DoC's satisfaction that all but one of these technology areas were already being carefully monitored and controlled through normal DoD procedures and that DoD officials had never intended to permit transfer of them to the Japanese in the first place. However, computer software source codes for the mission computer and the flight-control computer remained areas of great contention and proved to be the most difficult area to resolve.²⁶

Source codes are computer programs usually written in a standard programming language. These languages permit the easy development and manipulation of the desired operating instructions for the computer by a computer programmer. Normally, however, computers are unable to operate with or "read" source codes. Thus, source codes must be compiled into machine language or object codes by a compiler program. Access to source codes, which include the programmer's notes, may permit the reconstruction of the methodology, logic, and development process used to write the computer program (Moteff, 1989).

²⁵"FS-X Adversaries Dispute Japan's Motives, Benefits" (1989).

²⁶Interview with a DTSA official, August 7, 1992.

The mission computer (also called the fire-control computer) is the central computer for the fighter's avionics systems. It coordinates the massive data flow and complex interactions of a variety of sensors, the radar, the navigation system, the armaments, and the cockpit displays. It is the critical node for the difficult task of integrating all the avionics systems and sensors and interfacing these systems with the pilot. In aircraft equipped with FBW technology, the flight-control computer processes the data input from numerous sensors indicating the speed and orientation of the aircraft and translates the pilot's control commands into the appropriate movements for the aircraft's aerodynamic control surfaces to achieve the desired flight response (Moteff, 1989).

U.S. government officials had originally envisioned the possibility, pending further review, of at least limited Japanese access to the source codes for the F-16 mission computer to allow modifications necessary to integrate the Japanese APA radar and other indigenous avionics. Some access to the source codes for the F-16 flight-control computer was also not explicitly prohibited because of the modifications required by the aerodynamic differences between the SX-3 and the F-16 and the Japanese desire to incorporate their own CCV capabilities similar to the AFTI F-16. The Pentagon argued that GD involvement in the development of FS-X source codes for the mission computer would provide greater insight into the Japanese industry capabilities and its indigenous avionics subsystems (Moteff, 1989; GAO, 1990, pp. 24-25).

The DoC countered that access to F-16 source codes for both these systems would enormously advance Japanese capabilities in the areas of avionics integration and FBW flight-control systems. Critics were concerned that, by transferring the mission computer source code, GD would be assisting Japanese industry in developing sophisticated system integration skills. FBW technology, of course, was planned for application to a new generation of commercial transports in the United States and Europe. Thus, these source codes, it was felt, had direct commercial aerospace applications and represented software development capabilities and technologies in which the United States currently enjoyed a large advantage over Japanese industry. Furthermore, the current F-16 digital FBW system had only recently entered into operational ser-

vice, and many experts considered it to be cutting-edge U.S. technology.²⁷

Victories for the Department of Commerce

After much debate, DoD and DoC officials finally agreed to completely deny access to the flight-control computer source codes. Experts concluded that the digital FBW flight-control system on the F-16 Block 40 version represented the state of the art and should not be transferred to the Japanese because it had clear commercial applications.²⁸ However, DoC and Pentagon officials could not agree on restrictions for the mission computer source code. Pentagon experts argued that a "sanitized" version of the source code, with all design methodologies and programmer notes removed, would provide little commercial benefit and would be needed to integrate the Japanese radar and avionics during the FS-X development program. DoC refused to accept this position, resulting in an impasse on this one technology area (GAO, 1990, p. 25).

In areas other than control of U.S. technology transferred to Japan, the interagency review team ended up endorsing most of the major clarifications to the FS-X agreements publicly suggested by the leading opponents in Congress and elsewhere but urged continuation of the program. These clarifications concentrated on the issues of establishing a permanent DoC supervisory role, guaranteeing 40 percent of production workshare, ensuring maximum commonality of design and components between the FS-X and F-16, and gaining better access to Japanese indigenous technologies. On the last issue, the team emphasized the need to improve the access process established in the 1983 Exchange of Notes and to more precisely define "derived" and "indigenous" technologies to

²⁷Some U.S. aerospace industry observers believe that the Europeans acquired important technology for the FBW system on their A320 Airbus commercial airliner through coproduction of the F-16. Interview with a senior U.S. industry official.

²⁸Most DoD officials maintain that the Pentagon never intended to transfer the source codes for the F-16 flight-control computer to the Japanese. They maintain that the only real debate was over the mission computer source codes.

facilitate access. There was also a recommendation for some off-the-shelf purchases of F-16s by the Japanese. However, "at least three or four basic issues" involving both substance and implementation remained unresolved by the March 10 deadline for a final interagency report.²⁹

On March 15, President Bush chaired "an unusual meeting" of the NSC to discuss the results of the interagency review. According to press accounts, three basic positions emerged during heated debates. Carla Hills, the USTR, and John Sununu, the White House Chief of Staff, reportedly led a faction demanding cancellation of the entire deal and replacing it with a demand for off-the-shelf purchases of F-16s by Japan. At the other extreme, Secretary of State James Baker, National Security Advisor Brent Scowcroft, and William Taft, the new Deputy Secretary of Defense, reportedly argued that the existing agreement should remain unaltered. Secretary Mosbacher apparently took the middle ground, urging continuation of the deal with revisions reflecting the major findings of the interagency review. At the conclusion of the meeting, President Bush decided to study the issues further before making a final decision.³⁰

At a second NSC meeting held on Saturday, March 18, President Bush essentially accepted Mosbacher's middle position by deciding to go ahead with the deal based on the existing MoU on the condition that the Japanese accept certain "clarifications" based on the interagency recommendations. Of central importance was a formal guarantee of a 40-percent U.S. workshare during production. However, the request for a Japanese purchase of some F-16s off the shelf was dropped as unrealistic. Nearly all the explicit restrictions on U.S. transfer of technologies in specific categories that DoC suggested were accepted. This is not surprising, since DoD officials maintain they had always essentially agreed with the DoC positions on all but one of the technology areas, that concerning the

²⁹Farnsworth (1989b); "Commerce to Assume Greater Role in Weapons Co-development Deals" (1989).

³⁰Farnsworth (1989b); "Commerce to Assume Greater Role in Weapons Co-development Deals" (1989). Farnsworth claimed that many "heated exchanges" had taken place during this meeting. Allegedly, General Larry Welch, U.S. Air Force Chief of Staff, had argued that F-16 technology was "old" and suggested "it could even be given away with no damage to the United States." Sununu had supposedly countered that many more recent upgrades to the F-16 had been funded and asked General Welch "what the Air Force had been doing with the money."

source codes for the mission computer. However, Pentagon officials also clearly saw no reason to formally and explicitly deny Japanese access to all the designated technology areas before the program was even approved.

The one major concession to DoD came on the issue of the mission computer software. Here, the president accepted the Pentagon position that sanitized source codes could be safely transferred to the Japanese. The president, however, also agreed to restrict the baseline F-16 technology used for FS-X to the Block 40 version, permitting no transfer of technology from later versions (Block 50) or other experimental versions, such as the AFTI F-16. In addition, Bush granted Mosbacher's wish for a permanent oversight role for the DoC on the FS-X program and in future agreements. Finally, the president decided to seek much stronger guarantees of access to Japanese-developed technologies as advocated by the interagency review (GAO, 1990, p. 25).

IMPOSING NEW CONDITIONS ON THE JAPANESE

On Monday, Secretary of State Baker, Dick Cheney, the newly confirmed Secretary of Defense,³¹ Secretary Mosbacher, and Brent Scowcroft met with the Japanese Ambassador, Nobuo Matsunaga. They told the ambassador that clarifications were necessary to obtain congressional approval of the FS-X agreement (Hoffman and Auerbach, 1989). The American officials requested a formal guarantee of a 40-percent workshare during production for U.S. industry (Lachica, 1989a, p. 4). They offered the Japanese two options for development of the flight-control computer source codes. In the first option, GD could develop the software with a limited number of Japanese engineers as observers. However, the Japanese would be denied any direct involvement or hands-on experience in the software development. GD would provide the object codes to Japanese industry as an end-item during the FS-X development phase. Sanitized source codes might be provided later during the production phase. The second option was independent

³¹John Tower, the original Bush nominee for Secretary of Defense, had failed to win confirmation by Congress over a variety of issues. Pentagon officials believe that the lack of a Secretary of Defense during most of the crucial interagency review period hurt their ability to defend the existing MoU against the attacks of the Secretary of Commerce and other officials.

Japanese development of the computer software and flight-control system with minimal U.S. industry involvement. The choice was Japan's (GAO, 1990, pp. 24-25). Finally, the senior officials requested "firmer assurances" and a "more precise commitment" for U.S. access to Japanese-developed technologies, especially MELCO's radar (Lachica, 1989a, p. 11).

The increasingly harsh debate in Congress and the formal U.S. request for clarifications to the MoU provoked widespread bewilderment, anger, and resentment in Japan. To some officials in JDA, industry, and the Diet, the U.S. government actions bordered on treachery. Throughout the nearly three years of political pressure from the Americans during the original negotiations, the Japanese had felt compelled to make one concession after another, moving themselves further and further away from their dream of indigenous fighter development. They had wanted to develop their own national fighter design but had agreed to base the FS-X on the F-16 as a major concession to the Americans. The U.S. side had pressured them to use as much F-16 technology as possible, even though the Japanese wanted to develop their own technology and incorporate it into the FS-X. They had finally agreed to give the Americans nearly half the development work and access to Japanese technology in an R&D program paid for entirely by Japan. Now Congress was accusing them of scheming to arrange a U.S. giveaway of F-16 technology, while the American government was coming back demanding more concessions after the deal had already been signed. At the very best, the U.S. government appeared unreliable and unable to live up to its commitments in the eyes of many Japanese. At worst, the Americans appeared duplicitous. Not surprisingly, voices began to be heard in Tokyo calling on the Japanese government to walk away from the deal and develop a national fighter on its own or in collaboration with the Europeans, as it had intended all along (for example, see Weisman, 1989, and Sneider, 1989a).

In response to the requests for revisions passed on through Ambassador Matsunaga, the Japanese government immediately dispatched Seiki Nishihiro to Washington. As the director of the JDA Policy Bureau and the senior government official directly involved in the original MoU negotiations, Nishihiro came to plead Japan's case against revision of the agreement. As one American

expert on Japan commented, "Sending their chief expert here indicates they are having difficulties swallowing American demands." (Farnsworth, 1989c.) After arriving early on Thursday March 23, Nishihiro met promptly with Baker, Cheney, Scowcroft, and Mosbacher at the Department of State. During these meetings, Nishihiro apparently provided assurances that U.S. industry would receive at least 35 percent of the production work. This was seen as a significant development, since only a month earlier Baker had been "politely rebuffed" when he had asked for similar assurances when in Tokyo to attend the funeral of Emperor Hirohito (Farnsworth, 1989d).

The U.S. officials argued, however, that due to the opposition expressed in Congress, formal written guarantees of the U.S. production share were needed, as well as clarifications of the U.S. rights of access to both derived and indigenous Japanese technologies. The U.S. side stressed that these guarantees were merely viewed as clarifications, not as changes to the existing agreements, that were necessary to win congressional approval. The Americans also assured Nishihiro that the U.S. government fully intended to proceed with the project and did not believe Congress would block it if the clarifications were forthcoming.³²

While not rejecting the American demands out of hand, Nishihiro apparently strongly pressed the Japanese case against any specific written revisions to the existing agreements. From the Japanese perspective, the U.S. government was reopening negotiations and asking for major changes to an agreement that had already been signed. The Japanese argued that the concerns raised by the Americans were already adequately covered in the agreement and that mechanisms existed for discussing different interpretations. From their viewpoint, the dispute boiled down to an issue of trust between two close allies. U.S. demands for clarifications seemed to imply a level of suspicion and lack of trust that the Japanese felt was offensive in such a relationship. As Masaji Yamamoto, director of the Equipment Bureau and chief negotiator on the MoU, explained the JDA position to Japanese viewers on a Tokyo television news program (Asatani, 1989):

³²"Japan Set to Award FSX Prime Contract Despite No Firm U.S. Deal" (1989).

Documents have been exchanged between Japan and the United States, and the MoU based on these documents has been signed. An agreement was reached on this issue in late November last year. In this connection, our position is that we will faithfully carry out the program in accordance with these documents and we also wish that the U.S. side would do the same. This is our basic position. As for the prospects, I naturally feel that, just as the President has stated, the program will be implemented and there will be no changes.

Unfortunately, the president had concluded that the program could not be implemented without the written clarifications in response to criticism from Congress. Nishihiro, who had originally intended to leave Washington on Saturday, felt compelled to extend his stay well into the following week because of the impasse that quickly developed between the two sides. Furthermore, the Japanese now injected new problems into an already difficult situation. It appears that, during the discussions over clarification of U.S. access to Japanese technology, a major additional issue reemerged regarding the wing. During the MoU negotiations the previous year, Mitsubishi had opposed GD participation on the wing development in part because it argued the composite technology involved was developed and owned by the firm, not JDA. MHI had finally relented on the American company's participation in wing R&D and manufacture, but the issue of technology transfer and ownership of data and know-how had not been completely settled (Auerbach and Hoffman, 1989).

Clarifying U.S. Access to Japanese Technologies

The chief clarification the Americans sought on technology access concerned a more precise definition of derived and indigenous technology. There had been no clear designation of FS-X technologies—other than the four Japanese avionics systems—as indigenous or derived. The U.S. side considered the distinction between the two categories as critical in its effects on potential U.S. access and, consequently, on Congress's attitude toward the deal. U.S. companies would be forced to negotiate payment and file requests through the JMTC procedures to gain access to any technologies identified as indigenous. As many critics in Congress and elsewhere had pointed out, the U.S. government already had the right

to do this outside the FS-X agreement, under the provisions of the 1983 Exchange of Notes. Furthermore, the record of U.S. access to Japanese technology under these provisions was not exemplary.³³

This problem loomed especially large with respect to the wing, particularly given the new issues of technology ownership that the Japanese had raised. A major selling point to Congress in support of the FS-X deal was the Pentagon's claim that it provided GD access to advanced and novel Japanese composite-wing technology. However, MHI now was insisting again that this was proprietary company technology that GD would have to pay for, even though the U.S. company would take part in developing and manufacturing prototype wing sets under contract to the Japanese government. If the U.S. side accepted this characterization, the wing could clearly be labeled Japanese indigenous technology, thus making it subject to negotiations over costs and to the JMTC procedures for access. The provisions for free flowback, of course, applied only to technologies considered derived. Therefore, the American side decided to seek explicit exclusion of the wing from the category of indigenous technology. Even more dramatic in potential long-term implications, U.S. officials now also sought to clearly and formally designate the four Japanese avionics systems as the only nonderived technologies, although leaving room for the possibility of recategorizing technologies later after the R&D program got under way.³⁴

From the perspective of many officials in the Pentagon, the emerging U.S. hard line on the technology category issue had a potential long-term benefit that was far more important than the symbolism of U.S. access to Japanese technology: controlling the degree of modification sought by the Japanese. More and more DoD officials now recognized that the Japanese intended to modify the baseline F-16 aircraft as much as possible. By defining all FS-X technology other than the four avionics systems as derived,

³³Interview with a senior DSAA official, August 6, 1992. However, as another U.S. official points out, the Japanese have never denied access to a technology specifically requested by the United States through the JMTC. Letter to the author from a U.S. Air Force officer, August 9, 1993. Besides the problem of U.S. access, many in DoD were also concerned about the final designation of FS-X technologies other than the four avionics systems because of the implications for the likely degree of modification of the baseline F-16.

³⁴Interview with a senior DSAA official, August 6, 1992; Sanger (1989).

some DoD officials hoped to signal the Pentagon's strong opposition to major modifications and to provide a disincentive to such modifications by making all Japanese changes available to U.S. industry free of charge.

In addition, the U.S. side pursued stronger mechanisms for gaining access to the officially recognized indigenous technologies represented by the four avionics subsystems, with emphasis on the radar. Many critics in Congress remained skeptical about the likelihood of U.S. access because of the poor track record of the 1983 Exchange of Notes and the alleged failure of the Japanese government to live up to the provisions of various other trade and market access agreements. Consequently, administration officials pressed the Japanese to guarantee beforehand some form of blanket approval by the JMTC of U.S. access to all indigenous technologies. The Americans also asked for more explicit restrictions on the use of F-16 technologies transferred to Japan in commercial applications. Finally, to avoid the appearance of renegotiating the entire MoU, U.S. officials suggested incorporating these new clarifications into "side letters" to the MoU.³⁵

With this extensive array of clarification demands on the table, the negotiations remained deadlocked. The most difficult issues remained U.S. access to Japanese indigenous technologies and the wing question. With the negotiations going nowhere, Nishihiro broke off discussions with senior administration officials and flew back to Tokyo on March 29 without having reached agreement with the Americans on any of these issues. Unfortunately, the domestic political situation in Japan made it vulnerable to right-wing attacks over the U.S. request for clarifications, making compromise difficult. Prime Minister Takeshita's government had been weakened by recent Cabinet resignations forced by the "Recruit" financial scandal. Elections for the upper house of the Diet were scheduled in July, leading some commentators to speculate that the stalemate would last at least through the summer. The situation seemed to worsen the next day as Kichiro Tazawa, JDA director general, warned the United States again that Japan would not accept any formal changes to the deal. The same day, a right-wing group led by Shizuka Kamei within the ruling LDP in the lower house of the Diet, formally asked the government to pull out of the

³⁵Interview with a senior DSAA official, August 6, 1992; Rubinien (1989).

FS-X agreement and proceed with indigenous fighter development.³⁶ To make matters worse, many members of Congress were outraged when Nishihiro announced on March 28 that JDA would sign a contract with MHI before the end of the month to begin work on the FS-X without a final agreement with the United States.³⁷

Japanese Frustration, Anger, and Resistance

In a fashion parallel to the interagency battle between the Pentagon and the DoC that took place in February and March, a major bureaucratic struggle over the requested MoU clarifications rapidly emerged in Japan, principally between JDA and the MOFA. JDA continued to resist American demands strongly. Reportedly, increasing numbers of JDA officials began advocating a return to indigenous development or collaboration with the Europeans. Preliminary Japanese feelers to the Israelis and to Dassault, the premier French fighter developer, were widely reported in the press.³⁸ But officials in MOFA forcefully advanced basically the same arguments for acceptance of the U.S. demands that they had used in 1987: The U.S.-Japan security relationship was too important to jeopardize over the FS-X issue. Furthermore, some Foreign Ministry officials argued that elements within the JDA were using the issue of the clarifications merely as an excuse to scuttle the agreement with the Americans and return to their preferred objective of indigenous development. With the increasing likelihood of the resignation of Prime Minister Takeshita over the Recruit scandal, MOFA insisted that the dispute had to be ended quickly, before the Prime Minister left office (Silverberg, 1989).

On Friday April 7, JDA Director General Tazawa met privately with Prime Minister Takeshita to discuss how to break the impasse.³⁹ A few days later, the Cabinet informed the U.S. govern-

³⁶"LDP Group Suggests Scrapping Accord" (1989).

³⁷The Japanese government budget cycle required the signing of a contract before the end of the fiscal year on March 31.

³⁸See, for example, de Briganti (1989) and Sneider (1989b). Dassault's Rafale fighter project still faced considerable uncertainties over funding, making foreign participation welcome. After the cancellation of the Lavi program in mid-1987, many observers believed Israel Aircraft Industries was actively seeking foreign partners in Asia as a means to continue fighter development activities.

³⁹"Takeshita, Tazawa Urge Caution on FSX Deal" (1989).

ment that Japan was prepared to compromise on the major issues in dispute. On April 11, Japanese officials agreed in principle to explicitly guarantee U.S. industry workshare during the production phase through an exchange of side letters. Bush administration officials optimistically reported that "there are only a few minor details" remaining to be worked out (Hoffman, 1989; Farnsworth, 1989e).

But a final settlement still remained weeks away. Realizing they were once again losing the battle to the political and foreign policy establishment, JDA officials, headed by Director Yamamoto of the Equipment Bureau, fought hard to win at least some counterconcessions from the United States in return for Japanese concessions and tried to limit the effects of the clarifications. As a result, the negotiations once again bogged down. JDA negotiators particularly focused on gaining a guaranteed 50-percent share for Japanese industry of the licensed production of the U.S. engine for the FS-X (Tolchin and Tolchin, 1992). The existing agreement stipulated off-the-shelf purchases of U.S. engines for the R&D program. To retain influence over the production program, U.S. officials, of course, had originally refused to discuss manufacturing arrangements for the engine during the production phase until after R&D, when a production MoU would be negotiated. Reportedly, JDA officials also tried to convince U.S. officials to permit transfer of the flight-control and mission computer software source codes. Japanese officials also strongly objected to U.S. demands for blanket JMTC approval of access to indigenous technology and to U.S. insistence on the unrestricted right to transfer technology from the FS-X program to third parties for defense purposes. Finally, JDA representatives also continued to argue that it was not feasible to designate a specific workshare percentage for U.S. industry during production before R&D had even begun (Silverberg, 1989). Indeed, Japanese industry had already made it clear that it expected its share of the work to rise significantly during the production stage.⁴⁰

During the second week of April, the Japanese ambassador and Under Secretary of State Robert Kimmitt conducted extensive discussions over the broad principles in dispute. The following week, Director Yamamoto returned to Washington to meet with senior

⁴⁰"Industries Concerned About FSX Negotiations" (1989).

Pentagon, Department of State, DoC, and NSC officials. Teams of technical experts from both sides met at the Pentagon for intensive negotiations over technical details. The American team, led by Maj Gen Ronald Yates, Director of the Air Force Office of Tactical Programs and other technical experts, refused to budge on most specific issues. The need to convince a hostile and skeptical Congress served as a primary U.S. argument for requiring Japanese acceptance of the requested clarifications without alteration. The high-level discussions continued into the next week, but eventually broke off again on April 25 without complete agreement. Although there was a "narrowing of difference," a variety of issues remained unresolved.⁴¹ The major sticking points centered on issues similar to those that had held up the MoU negotiations in 1988 for six months: the specific designation of derived and indigenous technologies and the larger issues of free and automatic U.S. access to the wing technology and assured access to Japanese indigenous technologies.⁴² Again, to some officials at the Pentagon, the real issue behind these disputes was really how much the baseline F-16 would be modified by the Japanese to produce the FS-X.

With the negotiations over the clarifications dragging on weeks longer than originally anticipated and both sides anxious for political reasons to break the deadlock, the Americans and Japanese finally agreed to accept a formal settlement based on broad principles and leave the most difficult details still in dispute to be hammered out latter through working-level negotiations. As Director Yamamoto perceptively explained to the press, "It would still take a great deal of time if we were to try and iron out all our points of difference."⁴³ Bush administration officials believed by this time that the Japanese had accepted all the most important principles requested in the clarifications and that further delay would only hurt the chances of gaining final approval in both Japan and the United States. U.S. officials hoped to submit the completed package of clarifications to Congress as soon as possible to forestall further erosion of support for the deal as both houses launched a major series of new hearings on the FS-X. Furthermore, on April 25,

⁴¹"FSX Talks End in Stalemate in Washington" (1989).

⁴²"Position on FSX Project Clarified" (1989); "FSX Deal Going to Congress with Production Share Assurances" (1989).

⁴³"FSX Sticker Shocks Japan" (1990).

Prime Minister Takeshita publicly revealed his intention to resign because of the Recruit scandal, raising the possibility of a temporary political vacuum in Tokyo. Japanese officials also wanted the public dispute settled before a change of government could interrupt the process.⁴⁴

THE ILLUSION OF A FINAL SETTLEMENT

Four days later, President Bush announced that the Japanese had accepted all requested clarifications and that the FS-X agreement would be submitted to Congress for final approval.⁴⁵ On April 29, Secretary of State James Baker and the Japanese ambassador exchanged two sets of side letters to the original MoU that included the new clarifications over production work and two-way technology transfer.⁴⁶ In addition, the two officials exchanged oral agreements on engine technology and technology reciprocity. The side letters and other agreements guaranteed about a 40-percent workshare to American industry during production, spelled out limitations on the transfer and use of American technology, and clarified U.S. access to Japanese technology. As a minor concession to the Japanese, the side letters ensured U.S. companies of "approximately" 40 percent, leaving some leeway for the Japanese in dividing up the production work. The oral exchanges also represented mild concessions by the Americans. In the oral exchanges, the Japanese restated their wish to license-produce the engine, and the Americans responded in a rather noncommittal manner that "licensed production is a viable production method for the FSX engine."⁴⁷ The oral agreements also promised a stable supply of eligible U.S. technology and parts to Japan for the program, by confirming both partners' commitments to a two-way flow of technology as originally established in the 1988 MoU.

But on these and most other issues, the side letters showed a nearly complete acceptance by the Japanese of the original U.S. positions on the clarifications. In addition to the guarantee of a 40-

⁴⁴"Japanese Government Shakeup Adds Urgency to FSX Negotiations" (1989); Devroy and Auerbach (1989).

⁴⁵For detailed overviews, see Morrocco (1989) and Shifrin (1989).

⁴⁶The letters are reproduced in House (1989c), Appendix 3, pp. 363-365.

⁴⁷"Two-Way Technology Flow Confirmed" (1989).

percent U.S. production workshare, the new agreements withheld transfer of the flight-control computer source codes, giving Japanese industry the option of accepting GD-developed software as an end item or developing its own code without American assistance. Mission computer source codes would be provided in a "sanitized" form. All technology transferred would be limited to the Block 40 F-16 version. U.S.-derived technology could not be transferred to any Japanese commercial applications. As one American government official explained, "they may not transfer [any technology derived from the F-16] to any other company or project outside of the FSX."⁴⁸

The new agreements also considerably strengthened U.S. access rights to new technologies developed in the program. The side letters guaranteed that the Japanese government would not block U.S. access to indigenous Japanese technologies represented by the four avionics subsystems. Ambassador Matsunaga's letter stated that "the Japanese side will transfer to the U.S. side, in accordance with previously agreed procedures, all the technologies which the U.S. side wishes to obtain."⁴⁹ In effect, the Japanese had reconfirmed the 1983 policy statement permitting transfer of nonmilitary indigenous technology and agreed in principle to accept some form of blanket JMTC approval for access to all indigenous military technologies. It was expected, however, that a more detailed formal agreement establishing the latter principle would have to be negotiated in the future. Yet, as a U.S. government official told the press, the new side letters guaranteed that "non-derived (indigenous) technology" would be made available for possible purchase by U.S. companies by making sure Japanese government authorities "don't have the option to say 'we're not going to sell you this.'"⁵⁰

Finally, the U.S. side not only more clearly limited the definition of nonderived technology to the four indigenous avionics systems but also included provisions to reclassify them as derived depending on the content of U.S. technology in the final developed articles. According to testimony before Congress presented by Joan

⁴⁸"Bush's FSX Clarifications Answer Many Congressional Concerns" (1989).

⁴⁹House (1989c), p. 364.

⁵⁰House (1989c), p. 364. Also see "Commentary Discusses Agreement" (1989), p. 12.

McEntee, Deputy Under Secretary of Commerce, the designation of indigenous Japanese technology for purposes of U.S. access had been "limited in four specific areas . . . termed 'non-derived technology' where "the United States does have access but has to pay." However, "if U.S. industry or if our technology is required to develop or complete" the four avionics systems, they would "move from the non-derived category to the derived category." As McEntee pointed out, these changes were "important because in the derived category the United States has total access to at no cost."⁵¹

From the perspective of most observers at the time, the Japanese had backed down on almost every issue and accepted all the new American conditions. Indeed, given the unbending U.S. stance throughout the negotiations, and strong pressure from the Foreign Ministry and elsewhere in the Japanese government, JDA had also been forced to drop its demands for counterconcessions from the United States, such as the transfer of the computer source codes and a guaranteed share of the engine production. As one correspondent reported from Tokyo, "senior Foreign Ministry officials . . . felt the deal had to be salvaged at almost any cost." Consequently, "the Japanese felt they had to make virtually all the concessions." (Togo, 1989.) While supporting the final resolution, one Japanese television commentator observed that it gave "the impression that not only was a settled agreement rehashed but Japan was forced to accept unjust and unfair terms." As a result, the commentator concluded, "it can be said that major problems remain unresolved."⁵²

Despite the appearance to many observers that the Japanese had accepted all the clarifications the Bush administration requested, the Japanese television commentator's observation proved correct: Many problems and difficulties still lay ahead on both sides. The blow-up in Congress and in a variety of executive agencies in early 1989, the enormously contentious U.S. interagency review of the agreements, and the many weeks of difficult negotiations with the Japanese that followed over the requested clarifications ultimately resolved very little. On the one hand, months of bitter congressional attacks and extensive hearings on the program

⁵¹House (1989a), p. 227. Also see GAO (1990), p. 19.

⁵²"Commentary Discusses Agreement" (1989).

still remained ahead, which brought into serious question the likelihood of the continued survival of the program. Furthermore, many, many months of difficult and frustrating negotiations with the Japanese would still be needed to clarify the "clarifications" to the MoU that the American side had fought so hard to win, and which, ironically, the Pentagon did not think were even necessary. And perhaps most importantly, the unending disputes over technology categorization and access would do nothing to stop Japanese transformation of the FS-X. Rather, it would serve to provide a distraction and cover while the Japanese pursued their strategy of changing the F-16 into the Rising Sun fighter.

**THE SHOWDOWN OVER FS-X
AND ITS AFTERMATH**

INTRODUCTION

The intense public controversy over FS-X did not end with the Japanese acceptance of clarifications to the MoU in late April 1989. The Bush administration still had an enormously difficult task ahead of it in trying to convince Congress not to scuttle the deal. The formal resolution of the clarification crisis was followed by months of hearings and debate in Congress. Despite the exchange of side letters engineered by the Bush administration, leading congressional critics of the FS-X program, led by Dixon and Helms in the Senate, and Levine and Richard Gephardt (D-MO) in the House, remained largely unconvinced that the clarifications satisfied their concerns. These and other members of Congress were still determined to block or radically modify the deal. At least five different congressional committees planned or already had commenced special hearings on FS-X.¹ Despite the more explicit limitations on the transfer of U.S. technology to Japan incorporated into the clarifications, and the promises of greater access to Japanese technology, strong doubts over the net benefit to U.S. industry of the two-way flow of technology persisted as the central area of concern.

During the course of the congressional hearings, technical experts presented compelling testimony arguing that the F-16 data package that was planned for transfer to Japan would have few di-

¹In the House, these included the Committees on Foreign Affairs; Science, Space, and Technology; Banking, Finance, and Urban Affairs; and Energy and Commerce. In the Senate, the Committee on Armed Services conducted hearings.

rect commercial applications that could be exploited by Japanese industry. On the other hand, experts also expressed considerable doubts about the long-term value of any Japanese technology that might be transferred to the United States during the program in compensation for the transfer of U.S. technology. Thus, while this testimony somewhat reduced concerns about directly aiding a commercial competitor through the FS-X program, it did little to quiet the skepticism that the program represented a real attempt at achieving technology reciprocity.

The seemingly endless outpouring of criticism and suspicion from Congress clearly outraged and embittered the Japanese security establishment (M. Green, 1990, p. 45). Even before the battle over clarifications, dissatisfaction with the U.S. imposition of collaboration was widespread. The angry view of one Japanese defense expert was not atypical:

[T]he U.S. will gain much, without paying any money. And Japan will only lose its advanced technologies while paying a lot of money.²

Ironically, the new dispute over clarifications and its aftermath dramatically increased the support in Japanese industry and the ASDF for a broad-based *kokusanka* policy in arms production. As one scholar points out, the 1989 disputes helped the Japanese industry "Defense Production Committee achieve what ha[d] been impossible since 1950—industry-wide support for *kokusanka*." (Takagi, 1989, p. 46.) Indeed, in mid-May, the committee succeeded in convincing the industry-wide *Keidanren*³ to issue a policy statement that for the first time officially sanctioned all the Defense Production Committee's positions on greater domestic military R&D spending and increased levels of indigenous defense industrial capabilities. The universal anger and outrage felt by supporters of *kokusanka* in industry and government over American actions did not bode well for the actual implementation and conduct of the FS-X program, since many of these people were

²Eiichiro Sekigawa, quoted in Takagi (1989), p. 28.

³The Federation of Economic Organizations, the main big-business lobbying organization in Japan.

concentrated on the working levels that would have to negotiate many of the remaining details and actually carry out the program.

The differences that remained to be ironed out would prove difficult to resolve indeed in this new atmosphere of increased distrust and hostility. These differences existed primarily in the area of U.S. access to Japanese technologies, a subject of critical concern to opponents of the program in Congress and elsewhere in the government. Despite appearances to the contrary, the problem of free U.S. access to the wing technology remained in reality completely unresolved and would continue as a major dispute leading to serious disruptions in the progress of the program. Working-level negotiations concerning the long-standing disputes over the designation of technologies as derived and nonderived (indigenous) and the details of access to different categories of FS-X technologies would ultimately drag on for nearly another year of frustrating discussions and disputes.

Under cover of these incessant disputes over technology transfer and flowback, the *kokusanka* supporters moved ahead with their strategy to transform the FS-X. The increased U.S. emphasis on restricting U.S. technology transfer greatly assisted the Japanese strategy. Without the excuse of severe U.S. restrictions on technology transfer, cost considerations would have probably forced the *kokusanka* supporters to accept licensed-produced or slightly modified versions of many U.S. F-16 components and other items. The U.S. refusal to transfer certain technology greatly aided the *kokusanka* supporters in pressing for more indigenous Japanese R&D. The most dramatic example of this phenomenon in the early phases of the program was the Japanese decision to develop indigenously the computer software for the flight-control computer. The *kokusanka* supporters also successfully pushed for a much greater degree of Japanese control over the design and development of the wing than originally envisioned on the U.S. side. During the start-up phase of the program, Pentagon officials attempted to influence the final design and configuration of the FS-X wing to make it more compatible with the projected Agile Falcon wing, so that the FS-X R&D work could contribute more directly to this U.S. development effort. The Japanese successfully resisted this initiative, ultimately designing and developing an entirely new wing with little U.S. input.

The growing U.S. obsession with technology transfer and access in response to the long congressional debate over FS-X contributed significantly to the initial success of the *kokusanka* supporters' strategy, although at the time few recognized the problem or the ultimate consequences. This chapter reviews the final showdown in Congress over FS-X and the immediate consequences for the program through March 1990.

SELLING FS-X TECHNOLOGY BENEFITS TO CONGRESS

Under U.S. law, any firm transferring American defense-related technology to a foreign country must receive an export license from the Office of Munitions Control in the Department of State. After approval of an export license, the president is required by the Arms Export Control Act to submit a certification explaining the details of the agreement to Congress. Congress is normally given 30 days to review the license. During this period, both houses may pass resolutions of disapproval, which stops the transaction. The president may veto the resolution, but Congress can override the veto with a two-thirds majority. Otherwise, the deal goes through.

On May 1, President Bush submitted the formal notification to Congress for the FS-X deal, including the recently negotiated clarifications. The same day, a group of senators led by Alan Dixon introduced Joint Resolution 113, intended to block the existing deal. One day later, Mel Levine led several representatives in introducing the similar Joint Resolution 254 in the House. White House officials counted votes, concluding that the resolutions had a reasonable chance of passage. Over the next week and a half, the administration sent a stream of high-level officials up to Capitol Hill to testify in favor of the agreement, including Secretary of Defense Dick Cheney, Secretary of Commerce Mosbacher, and Deputy Secretary of State Lawrence Eagleburger. These officials stressed the value of the recently negotiated clarifications in meeting congressional concerns over production workshare and technology flow and placed great emphasis on the importance of preserving the strong security relationship with Japan (House, 1990a, pp. 44-45). Nonetheless, like Chairman Nicholas Mavroules (D-MA) of the

House Armed Services Committee, many members of Congress remained "underwhelmed" by the MoU clarifications.⁴

A fundamental component of the continuing congressional opposition to the revised FSX deal was persistent skepticism over the value of Japanese technology to which the agreement provided access. Many members of Congress viewed this issue as being of critical importance, because they considered access to Japanese technology as a form of compensation for the transfer of U.S. technology. With the guarantee of 40 percent of the production work now in hand and with continuing concerns over the commercial value of F-16 technology transferred to Japan, the relative value of the Japanese technology potentially available to U.S. industry rose to even greater prominence in the debate. In recognition of this situation, administration officials played up the benefits of U.S. access. While emphasizing that DoD did not negotiate the FS-X agreement to gain access to Japanese technology, Secretary Cheney and others nonetheless stressed the potential benefits to the U.S. defense industry of acquiring manufacturing technology for the APA radar T/R modules and the composite wing. Testifying to the Senate Committee on Foreign Affairs, Secretary Cheney insisted that the wing was "an area where we may have something fairly significant to learn from them." (Senate, 1989b, p. 83.) In the area of T/R modules, Cheney claimed that access to Japanese manufacturing technology could potentially save the United States many millions of dollars on U.S. defense programs. Secretary Mosbacher concurred that "those are the two areas where we think we can have significant gain."⁵

Supporters of the deal also began reemphasizing the argument that technology acquired on the FS-X program would have direct benefits and applications to existing U.S. military aircraft programs, particularly the Agile Falcon. Cutbacks in the 1990-1991 defense budget that eliminated funding for the Agile Falcon program on April 17 lent a new urgency to these arguments. Belgium, Denmark, Norway, and the Netherlands were already participating with the U.S. Air Force and GD in a predevelopment

⁴"Administration Tells Congress FSX Clarifications Are Adequate" (1989).

⁵Senate, 1989b, p. 3; also see "FSX Review Panel to Monitor Tech Transfer Compliance" (1989).

study of Agile Falcon options, and Turkey was expressing strong interest in joining the effort. As a result, configuration studies and predevelopment work continued. Some observers believed the funding problem only marked a delay in the program and would actually prove beneficial, because a delay of a few years would lead to a better synchronization of U.S. Air Force and European replacement schedules. However, with the cancellation of development funding for the time being, the Air Force could no longer support development of the enlarged composite Agile Falcon wing, thus requiring another program, such as FS-X, to pick up the tab.⁶

Thus, at the height of the congressional debate over the MoU clarifications, government officials began raising the possibility of directly substituting the larger wing, developed for the FS-X with Japanese money, for that used on the Agile Falcon. Of course, this had been the hope of many DoD officials since the early FS-X negotiations in 1986 and 1987, but now the potential benefits appeared even greater because of the funding cuts. According to one government source, "certainly the [advanced cocured composites] technology if not the planform" could be used free of charge for the U.S. fighter modification program.⁷ Indeed, "administration officials" were paraphrased in the industry press a few days later as claiming:

Agile Falcon . . . will probably reappear in a later budget with much of the development work done, thanks to similarities between it and the FSX. That's one reason why it's important that the U.S. proceed with the FSX deal . . . so that a vastly improved, Japanese-funded F-16 will be available in the late 1990s as a complement to the Advanced Tactical Fighter—despite a lack of U.S. funds for Agile Falcon development.⁸

⁶"Cheney Grounds Agile Falcon" (1989), p. 3.

⁷"Agile Falcon Predevelopment to Continue" (1989).

⁸"Agile Deal" (1989).

GAO Questions the Value of Japanese FS-X Technology

Yet these claims from senior administration officials about the potential value of access to Japanese technology and the application of the wing to Agile Falcon continued to meet with deep skepticism from leading congressional opponents. Typical was the statement by Representative Mel Levine in response to testimony offered by Cheney and Mosbacher:

U.S. companies are far ahead in phased-array radars and have more experience in co-cured composites. Mitsubishi boasts of new materials technology, but has not yet demonstrated its ability to anyone from U.S. industry or U.S. government. We should not pin approval of this agreement on hopes and optimistic assumptions, when we have no evidence demonstrated thus far to support them. (Senate, 1989b, p. 113.)

The preliminary results of a GAO study made available to Congress in early April strongly encouraged these types of negative assessments and made the job of administration advocates much more difficult. The study, originally requested by Dixon, Helms, and other senators early in the year, raised serious questions about the value of Japanese technology to U.S. defense firms and U.S. military requirements for the technology. GAO officials briefed the senators on their preliminary findings at the beginning of April, spurring renewed opposition to the deal from Dixon and others.⁹ Dixon concluded from the briefing that there was "no evidence at all that the Japanese are giving us any useful technology."¹⁰

The original GAO briefing was not available to the public, but officials later entered open versions of the preliminary findings into the public record during various congressional hearings on FS-X. The GAO study drew primarily on extensive interviews with U.S. industry, Pentagon, and other government officials. However, no Japanese industry or government officials were queried. The study concluded that "overall, the United States has superior composites

⁹"Dixon Renews FSX Opposition After GAO Briefing" (1989); also see Farnsworth (1989f).

¹⁰"Opponent Concedes FSX Deal Is Improved, 'But Not Enough'" (1989).

technology and appears to be ahead in radar development," but qualified this assessment by noting that "the United States still has limited information from which to make meaningful comparisons about these Japanese technologies." (GAO, 1989, p. 5.)

GAO's evaluation of the wing echoed the DoD assessments of 1986 and 1987 about the lack of proven capability, potential high risk, and inherent problems with composite wings. It confirmed (GAO, 1989, p. 5) that

DoD and industry officials do not have solid information as to whether or not Japan can really produce the wing as planned The United States does not know exactly what composites will be used or how the Japanese plan to tool for production.

It reported the views of U.S. structural and design engineers that "the Japanese approach is high risk." The GAO report catalogued such potential problem areas as quality control, tooling complexity, internal access and inspection, and battle-damage repair. Most importantly, the report concluded that "U.S. industry's basic knowledge of advanced composites is superior to Japan's." In an apparent reference to Agile Falcon and other ongoing U.S. programs, GAO also concluded that the "U.S. military requirement for the Japanese composite technology appears to be modest." (GAO, 1989, pp. 5-7.)

GAO reported that U.S. government and industry sources knew so little about Japanese developments in the low-cost manufacture of T/R modules for their APA radar that no accurate assessment of the potential value of the technology to U.S. industry was possible. Nonetheless, the overall tone of the assessment remained skeptical. It pointed out that "U.S. industry is developing similar technology for the next-generation fighter aircraft," but that cost reduction continued to be a serious problem. Yet it remained "unclear what the Japanese module costs are estimated to be at this time because the United States has limited information about their technology." Because of the lack of data, "U.S. industry officials expressed reservations about Japan's ability to bring down the module costs quickly." Therefore, the report concluded (GAO, 1989, p. 8) that

[G]iven the state of U.S. industry module development, it is unclear what benefits can be derived from the Japanese technology

. . . . [W]ithout firm Japanese data, it is impossible for the U.S. government or industry to make a reasonable assessment at this time.

In addition, the report reminded Congress that, since the radar had been labeled nonderived technology, U.S. industry would have to pay some indeterminate price negotiated with Japanese companies to gain access to the technology (GAO, 1989, pp. 8-10).

Passage of the Byrd Resolution and Conditional Approval of FS-X

Boosted by the preliminary results of the GAO study, congressional opponents of the deal continued to insist that the balance of the two-way flow of technology favored Japan far more than the United States. However, administration testimony detailing the MoU clarifications and, more important, arguments that rejection of the deal would severely damage the U.S.-Japan security relationship and result in indigenous FS-X development, led several senators to waver in their opposition. In addition, the White House heavily lobbied Republican senators not to vote against the president on one of the first major political disputes of his presidency. As a result, on May 11, the Senate Foreign Relations Committee managed barely to muster the votes necessary to support the administration stance by narrowly defeating SR 113 by a vote of nine to eight. White House lobbying had achieved its desired effect. But the political battle was far from over. Because of lingering doubts widespread even among those who had supported the administration, the committee decided to forward the resolution to the floor for debate by the full Senate. According to Senate staffers, even though the committee had defeated the measure, the real political battle over FS-X would now begin in earnest on the Senate floor.¹¹

Yet to leading opponents of FS-X, the initial head counts did not seem to support a continuation of a direct assault on the administration position. Unsure whether they had the votes to pass the Dixon resolution in the face of continued high-pressure lobby-

¹¹"Senate Committee Votes Down FSX Killer Resolution" (1989); also see House (1990a), pp. 44-45.

ing from the administration, and even more uncertain over the prospects of successfully overriding an expected presidential veto, opponents led by Senator Robert Byrd (D-WV) decided to provide a third option that could be supported by senators unhappy with the deal but unwilling on foreign policy or political grounds to oppose the administration.

The Byrd measure granted congressional approval for the agreement but added even more restrictions and clarifications to the deal, aimed at further tightening up workshare and technology transfer provisions. Byrd explained that the Senate had "to send a message to our own wimpy diplomats that we're not going to take it lying down anymore."¹² His resolution required the provision of a minimum workshare for U.S. industry of at least 40 percent of the total value of the production program when the production MoU was eventually negotiated, including lifetime requirements for spare parts, support equipment, and maintenance. This expansive definition of production work could significantly increase the likely workshare on the program for American industry over the lifetime of the program and was expected by administration officials to be totally unacceptable to the Japanese. The Byrd measure also required withholding of "critical engine technologies," such as the hot section and digital fuel control technologies, if Japanese industry produced the engine under license. It further strengthened the oversight role of the Secretary of Commerce and called for regular review of the implementation of the MoU provisions by the GAO during the course of the program (Lachica, 1989b).

Although the Byrd resolution added nothing dramatically new to the existing agreements, it aggressively tightened up areas of the MoU that still caused concern to members of Congress. Furthermore, it placed extensive preconditions and restrictions on a future production MoU for which negotiations were not even envisioned to begin for several years. Nonetheless, on May 16, the full Senate passed the Byrd resolution overwhelmingly by a vote of 72 to 27, and it was substituted for the original language in SR 113. This vote provided five more votes than necessary to override the expected presidential veto. A week later, the House Foreign Affairs Committee approved a similar, although less binding, resolu-

¹²Quoted in Rasky (1989).

tion.¹³ But after considerable parliamentary maneuvering and further debate, the full House passed a resolution in early June identical to the Byrd measure by a convincing majority of 241 to 168.

Despite the impressive margins of victory mustered by the resolution's supporters, the president made it clear that he intended to veto SR 113 even though it included a conditional approval of the FS-X deal. Whether that veto could be sustained remained highly uncertain. Yet whatever the outcome, it was now clear that the FS-X program would not be entirely blocked by Congress.

Experts Challenge Commercial Value of F-16 Data for Japan

Many factors had contributed to the administration's initial success, including heavy lobbying by the White House to support the new president and concern over jeopardizing the larger U.S.-Japan security relationship. In retrospect, however, many staffers claimed a decisive element, particularly in the Senate, had been the findings of a report undertaken by the nonpartisan Congressional Research Service (CRS) first presented to Congress in mid-April (Moteff, 1989). This study was important because it expressed strong skepticism about the alleged commercial usefulness of the U.S. technologies transferred to Japan and painted a slightly more optimistic picture than found in the GAO report about the potential value to U.S. industry of access to Japanese indigenous technologies. According to some sources, the findings of the CRS report had been at least as important as the clarifications to the MoU in undermining opposition to the deal in the Senate.¹⁴

The CRS study attempted to present a net assessment of the relative value of the two-way transfers of technologies, with a particular emphasis on the likely value for commercial aerospace applications of the F-16 technology transferred to Japan. In the latter area, the study concentrated on the F-16 "airframe package" and the avionics source codes. It noted that the Japanese aerospace industry suffered from a variety of serious structural prob-

¹³"House Panel Approves Compromise FSX Resolution" (1989).

¹⁴"CRS: FSX Doesn't Address All Japanese Aircraft Industry Ills" (1989).

lems, including "limited experience in designing and integrating large complex systems such as commercial transports and advanced military aircraft." While conceding that "transferring F-16C technology undoubtedly would give the Japanese a higher base from which to work," it concluded that "it is not clear how the transfer of the airframe technology and the limited design and test data . . . addresses the more fundamental R&D problems confronting the Japanese aerospace program." Perhaps most important, it repeated the industry and DoD view that "the F-16 airframe technology, and fighter design in general, has little potential for direct commercial spin-off." Even in the area of future supersonic commercial transports, CRS concluded that "it is not clear that F-16C airframe design would have any direct application . . . beyond that which the Japanese have already acquired or are developing." (Moteff, 1989, p. 8.) The study came up with similar conclusions for the mission computer source codes: "It is doubtful that the mission code for the F-16C has much potential for commercial spin-off." (Moteff, 1989, p. 10.)

Equally important, the CRS report also portrayed the potential U.S. access to Japanese nonderived technologies in a somewhat more favorable light than the GAO. In the case of the APA radar, it determined that "to the extent that the Japanese have historically excelled in semiconductor manufacturing, the United States may be interested in what the Japanese have been able to accomplish and how." The FS-X agreement would permit U.S. "access to basic design, performance and cost data" on the radar and would allow the United States "to purchase or license the technology if they so desired." Since the FS-X radar had "little immediate application in the commercial sector," Congress did not have to be concerned about the commercial implications of this development effort (Moteff, 1989, pp. 7, 10, 11). In a like manner, the "cocured wing box manufacturing technology may offer limited benefits in future F-16 retrofit or modification programs" and could have "broader implications" depending on the outcome of the R&D program. Thus, in marked contrast to the GAO findings, the CRS study concluded that the FS-X program provided U.S. access to Japanese "technology that could be potentially valuable," arguing that "purchase or possible licensed production of phased array radar transmitting/receiving elements may offer the most direct benefits." (Moteff, 1989, p. 11.)

The CRS report provided strong independent confirmation of the testimony that Congress received during the many weeks of hearings over the FS-X from representatives of many of the leading U.S. aerospace prime contractors. During the period of intense scrutiny of the deal in early May, senior officials and engineers from GD, McDonnell-Douglas, Boeing, and the Aerospace Industries Association (AIA) trade group testified in favor of the FS-X agreement with the added clarifications. A central theme of their testimony was that, with the restrictions included in the MoU and the clarifications, the F-16 technology transferred to Japan would have few if any direct commercial aerospace applications and that access to Japanese technology would be potentially beneficial.

Not surprisingly, Herbert Rogers, GD's President and CEO, assured the House Committee on Foreign Affairs that "F-16 technologies have little application to commercial aircraft design or manufacturing." In exchange for that technology, Rogers insisted that "valuable technologies will flow back to the U.S." In regard to the radar and wing, "preliminary evidence suggests that they have succeeded in developing mass-producible, cost-effective systems—something yet to be done in the U.S." (House, 1989c, p. 174.) Based on its experience with several joint commercial transport programs with Japanese firms, Boeing backed GD's position. Philip Condit, the Executive Vice President of Boeing Commercial Airplanes, reminded Congress that

[T]he government has established institutional safeguards that prevent the irresponsible transfer of technology, which we assume are in place to judge the FSX arrangement. (House, 1989a, p. 227.)

Joel Johnson, Vice President of the AIA, undoubtedly caused Mr. Condit some discomfort by testifying that such collaboration with Boeing "is far more relevant to the design and production of civil aircraft than any spinoffs from building fighters." (House, 1989c, p. 168.) Finally, in perhaps the most compelling testimony on this issue, Robert Leonard, Director of Program Engineering and Advanced Technology at McDonnell-Douglas, presented a detailed technical briefing to members of Congress discounting concerns over commercial use of transferred F-16 technology. Leonard demonstrated that fundamental differences in mission and perfor-

mance requirements between fighters and airliners "limit transferability of fighter technology to commercial transport aircraft." Furthermore, he showed that even much of Japan's indigenous FS-X technology had little commercial application beyond military fighter programs. He concluded that

[F]ighter composite wing and fuselage technology will not enable early composite applications to transport wings or fuselages. Such applications, by U.S. or foreign industry, will require intense technology development and validation efforts over the next ten years. (House, 1989a, p. 262; emphasis original.)

Indeed, in addition to the representatives from the three aerospace prime contractors and the AIA, virtually every aerospace technical expert who testified before Congress judged the commercial applicability of specific F-16 technology transferred to Japan to be minimal, given the restrictions evident in the MoU and the clarifications. These witnesses included such experts as Dr. Norris Krone, Director of the Maryland Advanced Development Laboratory and former Director of the Air Vehicle Technology Office of DARPA, and Dr. Jan Roskam, Professor of Aerospace Engineering, University of Kansas.¹⁵ Furthermore, nearly all the witnesses with aerospace engineering expertise tended to be more optimistic about the possible benefits of U.S. access to Japanese technology than the GAO study conducted early in the year.

The unified front the expert industry witnesses presented, combined with the findings of the CRS report, tended to mute the criticism of congressional FS-X opponents, who saw the program as a technology giveaway that would transform Japan into a commercial aerospace competitor. However, it did not entirely eliminate their concerns, for two reasons. First, witnesses testifying for U.S. aerospace "second-tier" suppliers, such as electronics and composite materials firms, as well as unions representing aerospace workers, remained highly skeptical or opposed to the agreement. They argued that the agreement might protect the interests of the U.S. prime contractors but not the suppliers and subsystem developers.

¹⁵Roskam actually "grudgingly opposed" the deal unless the U.S. government blocked the transfer of certain technologies, mainly involving source codes and advanced composites know-how. However, the technologies listed by Roskam had indeed been forbidden for transfer by the agreement. See House (1989a), pp. 53-68.

Second, many of the technical experts who had testified that Congress need not worry about the transfer of F-16 technology also pointed out that Japanese industry would nonetheless still gain considerably from the program. They argued that it was not so much the specific F-16 technologies that the United States would transfer but the experience gained by the Japanese in working together with U.S. firms to develop the FS-X that would substantially increase their overall aerospace capabilities, particularly in system integration, avionics, and composites.

For example, a vice president from Hercules Inc., a leading American composite materials firm, testified that

[T]he Japanese have the most to gain from the FS-X program in terms of gaining a total understanding of the complete system required to produce an effective "composite" aircraft. (House, 1989a, pp. 51-52.)

Dr. Krone observed that "the actual technology level being pursued in the program is for the most part already in the hands of our foreign competitors." He went on to say, however, that

[T]he principal benefit to the Japanese will be derived from the close association with the American engineers and other technical personnel that can show them skills and ways of doing things that can only come from experience in the design of fighter aircraft. (House, 1989a, pp. 66-67.)

These technical experts and others nonetheless supported the agreement despite these learning benefits for Japanese industry, for two basic reasons. First, the existing deal permitted the Americans to exercise control and influence over the development of Japanese capabilities and the marketing of the end product in a manner not possible if the Japanese built the FS-X indigenously or in collaboration with the Europeans. This theme appeared in the testimony of most representatives from U.S. industry. For example, Dr. Vernon Lee, GD's head of the FS-X program, argued that a basic rationale for collaboration was "to keep the competition from developing a completely independent capability." Herbert Rogers added that

[T]he use of a U.S. baseline system by Japan brings with it U.S. control over the markets to which that system when fully modified might be introduced—a kind of control with important political and economic consequences. (House, 1989c, p. 176.)

Second, because of the considerable transfer of U.S. expertise that would inevitably take place in such programs, most technical experts argued that gaining access to new Japanese developments and indigenous technologies remained an important component in ensuring that collaborative programs benefited the United States. Dr. Krone concluded that “on balance it appears as though the technological benefits to the U.S. of the FS-X agreement, in an absolute sense, will be as great as the benefits to the Japanese.” He qualified this statement, however, with an important caveat: “This opinion assumes that we have access to the technologies of the avionics subsystems that are to be furnished by the Japanese, areas where they have good capabilities.” (House, 1989a, p. 67.) The AIA summed up its position for Congress similarly:

We believe that at this time the FSX deal as negotiated is probably about the best agreement that is realistically achievable We would encourage the Congress to allow for its implementation, with the proviso that the U.S. government should monitor closely the willingness of Japan to make available technology to the U.S. (House, 1989c, p. 168.)

In sum, the overwhelming weight of the testimony from technical experts to Congress supported the contention that F-16 technology transferred to Japan would contribute little to the development of a Japanese commercial transport industry. The *experience* gained through the actual developmental process for FS-X, however, could contribute significantly to enhancing Japanese capabilities for developing future fighters and airliners. Here, the real benefit of the FS-X program for the United States came from the opportunity to exercise guidance and control over the development of Japanese capabilities and gain access to and knowledge of new technologies and processes developed by the Japanese. These arguments unquestionably made a significant contribution to the ultimate defeat in mid-May of the anti-FS-X measure sponsored by Senator Dixon. The defeat of that measure effectively ended congressional attempts to block the deal.

CONTINUING CONGRESSIONAL OPPOSITION, GROWING JAPANESE ANGER

Nonetheless, the overwhelming passage of the Byrd measure by both houses shortly thereafter clearly demonstrated the depth of the feelings of ambivalence and skepticism that remained in Congress over the two-way technology transfer provisions and other aspects of the FS-X agreement. Even though President Bush made it clear from the beginning that he would veto the Byrd resolution, congressional opponents not only hailed the passage of the measure but served notice that they would fight fiercely to override any veto. As noted above, this measure added virtually nothing new substantively to the existing agreement but served to send a clear message to the Executive Branch about Congress's determination to make sure that the workshare and technology-transfer provisions of the agreement were carried out to the letter. Yet the administration believed the Byrd measure, by legislatively dictating specific terms for a future production MoU, placed unconstitutional constraints on the Executive Branch, could legally require a renegotiation of the existing MoU, and would further outrage the Japanese, possibly to the point where they might pull out of the program altogether. Indeed, as the dispute between the Executive and Legislative branches dragged on well into September, the Japanese became increasingly frustrated and embittered with the seemingly endless criticism from Congress and the continued uncertainty over the final status of the program. To make matters worse, as the summer drew on, it became obvious that the clarifications over the flight-control computer source code and U.S. access to the wing technology had not resolved all existing problems and were contributing to new difficulties.

U.S. government and industry officials considered the passage of the Byrd resolution by the House on June 7 as providing the formal go-ahead for the program, despite the anticipated battle over the threatened presidential veto of the measure. President Bush had promised to veto the resolution, and initially most observers believed congressional opponents did not have sufficient votes to override. Some expected the issue to be settled before the upcoming July 4 recess. Once a veto had been sustained, all potential congressional obstacles would be removed. Consequently, on June 7, the government issued GD an export license for trans-

ferring F-16 data to Japan, and the American company notified Japanese officials of the formal start of the program. Pentagon and Air Force officials made their final personnel selections for staffing the U.S. side of the TSC. Observers anticipated a possible Japanese delay of "about a week" to review the new clarifications and assess the political situation in Congress. Nonetheless, GD expected Japan to make the first scheduled payment toward the license fee before the July 7 contractual deadline, soon after which it would begin transferring F-16 data to MHI.¹⁶

Unfortunately, the scenario did not play out that way. Led by Alan Dixon, Senate opponents delayed sending the Byrd resolution to the White House until well after the July 4 recess, thus preventing Bush from vetoing the measure. Their purpose was to avoid a pocket veto and gain time to line up the necessary votes to override. The success of their delaying tactics further angered JDA officials and important members of the ruling LDP, already "badly bruised" and embittered by the FS-X debate. JDA officials considered the delay as further "harassment" by the United States and began expressing serious doubts about the administration's assurances that the Byrd resolution would ultimately be successfully vetoed. One Japanese official complained that the failure to stop the Byrd resolution would render the FS-X MoU and the clarification side letters "meaningless."¹⁷

Several concrete indications of deepening Japanese resentment emerged in late June. JDA began causing subtle delays in the program.¹⁸ In one not-so-subtle delay, JDA instructed MHI to break off contacts with GD until the political situation in Congress was clarified. As a result, GD officials expressed concerns that Japan would also request a delay in making the first license fee payment, thus preventing the transfer of F-16 TDPs and pushing back the start-up of the project further. Around the same time in Japan, members of three LDP task forces on security and defense issues began pressing JDA to immediately select the option of indigenous development of the flight-control computer source codes. Press accounts quoted task force members as expressing "anxiety" that U.S.-developed source codes "have [had] bad results in the past,"

¹⁶"U.S. Gives GD FSX Go-ahead; House Votes Conditions on Deal" (1989).

¹⁷"Mitsubishi, GD, Resume Contacts as Governments Reach Pact" (1989).

¹⁸"Chagrined Japan Unlikely to Seek FSX Pact Renegotiation" (1989).

and that Japanese pilots "could not operate the FSX in safety if the airplane has American-made source codes."¹⁹

It will be remembered that the MoU clarifications offered the Japanese the options of either selecting U.S.-developed source codes that would be handed over as a black-boxed end item or developing the codes entirely on their own. Behind the scenes, both administration and industry officials urged the Japanese to select the first option to reduce costs and save time. The U.S. side doubted the Japanese possessed the experience and know-how to develop the source codes in a timely and cost-effective manner. They feared a decision for indigenous development would further delay the R&D program and lead to an even greater likelihood of significant growth in R&D costs, which they believed were already grossly underestimated by the Japanese. Indeed, U.S. industry spokesmen expected that indigenous development of the source code would add from one to three years to the development schedule and a 10-percent increase in the R&D costs.²⁰ U.S. officials counseled the Japanese to leave resolution of this problem to the technical experts staffing the bilateral TSC, thus ensuring U.S. input to the final decision. But according to press accounts, Japanese advocates of indigenous development of the source codes were willing to accept an expected delay of up to two years in the R&D program to develop their own code and avoid any further dependence on U.S. black-boxed technology.²¹

In an attempt to stave off further hardening of the Japanese position, senior administration officials, including Secretary Mosbacher, scrambled to reassure the Japanese side that the president would definitely veto the Byrd resolution. By the end of June, these administration efforts had convinced the Japanese to go ahead with the initial \$25 million license fee payment and reopen direct contacts with GD. On June 30, a team of MHI engineers arrived in Ft. Worth to begin discussions on program details. Nonetheless, Japanese officials continued to warn that survival of the Byrd resolution in any form would necessitate a renegotiation of the MoU and present serious obstacles for the smooth progress of

¹⁹"Japan Moves to Develop Its Own Fly-By-Wire Source Codes for FSX" (1989).

²⁰"Mitsubishi-GD Contracts Clear Way for April 1 FSX Start" (1990).

²¹See, for example, Barrie (1989); and "Japan to Independently Develop Flight-Control Software" (1989).

the program. At the same time, JDA provided no official word on what the Japanese would ultimately decide to do with respect to development of the flight-control software.²²

The Campaign to Override the Bush Veto of the Byrd Resolution

Meanwhile, Senate opponents redoubled their efforts to save the Byrd resolution from the near certainty of a presidential veto. Dixon and Byrd attempted to lobby the president directly not to veto the measure and also considered the possibility of attaching it to the defense authorization bill as another means of forcing approval. They circulated a letter to colleagues to retain at least the necessary 67 votes for an override out of the original 72 who had voted for the measure. By early July, they appeared to be meeting with some success. The two senators apparently convinced key Republicans, such as Senators Danforth and Heinz, to side with them. However, administration supporters, led by Senator Richard Luger (R-IN) and others, also worked in support of the president. While the administration expressed confidence that a veto could be sustained, the actual outcome clearly remained in doubt.²³

The long-anticipated presidential veto finally came on July 31. Senators Byrd and Danforth intensified their efforts to muster the necessary support for an override vote before the beginning of Congress' summer recess, only five days away. However, President Bush had broadened the parameters of the debate in his veto message by emphasizing his belief that the Byrd measure would "unconstitutionally infringe on the powers of the Executive" (House, 1990a, p. 49) by dictating the content of a future agreement with a foreign country that had yet to be negotiated. With much last-minute business on the Senate agenda and little time available to debate the new issues raised by the president, the Senate leadership decided to delay the vote until September when Congress returned from its summer recess.²⁴

²²"Chagrined Japan Unlikely to Seek FSX Pact Renegotiation (1989).

²³"FSX Opponents Eye DoD Authorization for Restrictive Amendment" (1989); "FSX Opponents Fail to Sway Bush as He Moves to Veto Restrictions" (1989).

²⁴"Quick FSX Veto Override Less Likely as Recess Approaches" (1989).

When Congress reconvened in early September, senators found themselves overwhelmed with numerous pressing issues that complicated the task of the FS-X opponents in trying to organize a quick override vote. Nine out of 13 appropriations bills to fund the government still had not been approved by the Senate, in addition to a myriad of new legislative issues that now demanded attention, all of which began diverting senators' attention from FS-X. As one staffer explained, "There's drugs, there's money bills, there's ethics, all basically things that have kind of overtaken FS-X in the minds of the members."²⁵ Meanwhile, administration officials turned up the pressure on Republicans to support the president and to avoid the embarrassment of an override of his first veto. Advocates on both sides nervously counted heads, with opponents claiming a two-vote margin and administration officials insisting they had a four-vote surplus. But nearly everybody agreed that "if Byrd loses this one he'll probably drop it and not pursue it."²⁶

After considerable debate and parliamentary maneuvering, the Senate leadership settled on September 13 for the final showdown vote over FS-X. As the date approached, lobbying by both sides intensified. Senators Byrd, Bingaman, Danforth, and Heinz circulated a letter to their colleagues late Tuesday, September 12, trying to counter the president's constitutional arguments by asserting that a failure to override would cede unprecedented authority over issues of trade and technology transfer from Congress to the Executive Branch. The president of the AIA countered with a dramatic last-minute appeal to senators to sustain the veto, warning that an override would "increase the determination" of the Japanese to turn to the Europeans to assist in the development of the FS-X, causing great harm to the future of the U.S. aerospace industry.²⁷ Both sides continued to insist right up to the vote that they would win, but as one staffer pointed out, "in the absence of a clear picture everyone's nervous."²⁸ While the White House claimed "cau-

²⁵Quoted in "FSX Veto Override Taking Back Seat to Money Bills, Drug Plans" (1989).

²⁶"FSX Override Attempt Likely Next" (1989).

²⁷"AIA Urges 'Swing' Republicans to Sustain Bush's FSX Veto" (1989).

²⁸"Close Vote Seen in Senate for FSX Override" (1989).

tious optimism" over the outcome, one supporter told the press that "it's no big surprise to say that's it's going to be dang tight."²⁹

Late in the evening on September 13, the Senate voted. By the closest of margins—a single vote—the Senate upheld the president's veto of the Byrd measure. Administration officials expressed great relief and satisfaction with the outcome of the vote. However, few observers believed that the administration had triumphed by successfully convincing 36 senators of the merits of their case regarding the FS-X. The White House had heavily pressured the 20 Republican senators, who had originally voted for the Byrd measure, not to embarrass the president. This pressure succeeded in convincing ten of these senators to switch sides for the override vote, including prominent long-time opponents of FS-X, such as Senator Warren Rudman (R-NH), whose vote had been considered pivotal.³⁰ In addition, by framing the veto in terms of the president's constitutional prerogatives, the White House had successfully diverted the final debate away from trade issues and the FS-X toward a discussion of the power relationship between the Executive and Legislative branches about foreign economic agreements. A Senate staff member claimed that such a strategy "was the only way [President Bush could win], because more than 70 Senators voted for restrictions on the first go-around. He didn't win it on the merits so he had to go the other way."³¹ Furthermore, the administration had virtually no success changing the minds of Democratic senators—all but one voted to override the veto. With 66 senators voting to override the veto, it is not surprising that an official congressional account of the vote concluded that the president's problems with Congress over trade issues and the FS-X were far from over:

The vigorous manner in which the President asserted his view of his prerogatives in the FSX veto message, and the fact that his veto was sustained by the narrowest margin, strongly suggest that the FSX debate was merely one major skirmish in a continuing executive-legislative battle over the United States' trade pol-

²⁹"Close Vote Seen in Senate for FSX Override" (1989).

³⁰"Rudman's Support" (1989).

³¹Quoted in "Senate Fails to Override Veto of FSX Restrictions 66-34 Vote" (1989).

icy. Should a controversy arise in the future, with similar ingredients, the outcome might not be the same. (House, 1990a, p. 52.)

AFTERMATH OF THE FS-X DISPUTE: JAPAN MOVES TO TRANSFORM FS-X

Lingering Suspicions

Following the dramatic Senate vote of September 13, the FS-X problem faded from the daily headlines almost as quickly as it had arisen in February and was soon replaced by numerous other pressing issues that demanded the immediate attention of Congress. Nonetheless, the bitterness of the debate and the bare margin of the administration victory helped further poison feelings on both sides of the Pacific and continued to reverberate throughout the FS-X program as it haltingly got under way. Widespread suspicions about the ultimate intentions of the other side ran deep on the working levels in both Japan and the United States, particularly on the question of technology transfer. Although many officials on both sides sincerely sought to leave the dispute behind and move ahead constructively with the work of cooperatively developing the FS-X, the suspicions and doubts lingered on with adverse affects on the progress of the program.

Perhaps even more important, the DoD and U.S. Air Force officials implementing the program from the American side now had to contend with the constant scrutiny of GAO monitors and close cooperation with the DoC, knowing that at any time a hostile and skeptical Congress might raise the FS-X issue again in the context of new trade frictions if the technology-transfer and workshare provisions were not carried out in strictest accord with the side agreements that had "clarified" the MoU. Unfortunately, those side letters had not fully resolved many of the most contentious issues, and after the long and bitter debate in Congress, many working-level officials in JDA and Japanese industry were in no mood to be accommodating. As one Japanese newspaper put it:

[N]ot all FS-X problems have been solved. Even in the middle of the development process, the U.S. Congress may very well present new demands depending on the situation with Japan-U.S. eco-

conomic and trade problems. The work must go on, while holding a live "bomb."³²

In late August, the TSC held its first formal meeting.³³ The American side was determined to be as accommodating as possible to the Japanese in an attempt to calm angry feelings and reestablish trust, but important questions had to be raised. A whole series of very sensitive issues and problems left hanging or incomplete during the bitter congressional debate still had to be confronted. The most important of these issues concerned development of the flight-control computer source codes, the size and design of the wing, and the long-standing question of U.S. access to and use of the wing technology. The Americans also raised issues of access to the APA radar and other nonderived technology.³⁴

Japan's Decision to Develop the Flight-Control Computer Software

The first issue was relatively minor but had potentially dramatic long-term implications for the R&D program. Over the summer, it had become increasingly evident that the Japanese were irrevocably committed to developing their own source code for the flight-control system. Continued U.S. warnings about the difficulty and cost of this software in Japan, particularly for a CCV fighter equipped with side-force maneuvering vertical canards, went unheeded. The TSC and U.S. industry still had to work out the details of specific workshare and tasks. The Japanese insistence on developing their own source code raised a new difficulty for work allocation, because Pentagon officials believed the extra development costs might require the Japanese to transfer more

³²"Independent Development of FSX, SSM" (1989).

³³The U.S. cochair for the TSC was an Air Force general officer. Other representatives included officials from DSAA, DTSA, the DoC and various Air Force offices. The Japanese side was cochaired by an ASDF general officer. He was accompanied by officials from TRDI, the ASO, the JDA Equipment Bureau, and other offices. An initial TSC meeting actually took place in February 1989 at Wright-Patterson Air Force Base. After the blow-up in Congress and the crisis over clarifications put the program in jeopardy, this gathering became known as a "pre-TSC" meeting, or TSC #0. The August 1989 meeting became the official TSC #1.

³⁴Letter to the author from a U.S. Air Force officer, August 9, 1993.

work to U.S. firms to maintain the 40 percent overall U.S. work-share. And, of course, the U.S. side continued to express concern over the effect on the program schedule, already delayed by at least a year, of taking on this additional development task.³⁵ Nonetheless, when confronted with a determined Japanese stance on this issue, the American side decided to defer to Japanese wishes, primarily to avoid further bad feelings and disruption of the program in the wake of the congressional debate.³⁶

The Japanese decision to develop the flight-control computer source code indigenously was, of course, the direct result of the decision that came out of the interagency review in March to offer the Japanese the source code only as a black-boxed end-item developed by GD. Ironically, this development moved the collaborative FS-X program even further away from the original DoD objective of preventing indigenous development. As a Japanese journalist pointed out, "as far as this point is concerned, Japan has gotten closer to its original, independent development plan."³⁷

The Japanese Move Toward a Unique National Wing Design

A second troublesome question that reemerged at the first TSC meeting was a renewed DoD interest in maintaining maximum commonality between the FS-X and Agile Falcon wing designs. It will be recalled that at the height of the congressional debate in May 1989, many Pentagon and industry officials stressed the direct benefit to U.S. fighter programs of free access to the FS-X wing developed entirely with Japanese funds. This renewed interest had been spurred by the cancellation of Agile Falcon funding in April and the realization that, as a result, the U.S. Air Force would not fund development of the enlarged wing originally planned for Agile Falcon. Continued development of the larger wing was also thought necessary to maintain a viable Agile Falcon alternative in addition to the Super Hornet, to attract the European developers of the EFA and Rafale. However, in the wake of the GAO FS-X re-

³⁵"Source Code Shuffle" (1989).

³⁶"Contract Agreements Continue to Slow FSX Progress" (1989).

³⁷"Independent Development of FSX, SSM" (1989).

port, many members of Congress continued to express serious doubts about the applicability and value of the FS-X wing to U.S. programs. Given this skepticism and hostility in Congress, the Pentagon's Office of Program Analysis and Evaluation (PA&E) had decided to examine seriously the feasibility of directly utilizing the jointly developed FS-X wing for the Agile Falcon, as well as a strategy for implementation (Amouyal, 1989, p. 1).

DoD consulted engineers at the Air Force's Aeronautical Systems Division who appeared enthusiastic about the idea. Unfortunately, the PA&E study, whose findings were made public in early June, highlighted a new problem with this initiative: The size and design of the wings intended for the two fighters had diverged considerably since 1987 when GD had made its original marketing proposals to the Japanese for the SX-3 design based on an early Agile Falcon concept. After selection of the SX-3, Japanese industry had gone ahead to refine their own wing configuration design for FS-X using the original 375-ft² wing concept envisioned for the SX-3 and the Agile Falcon in 1987 as the baseline. Throughout 1988, however, GD had continued to study different wing design configurations and sizes for the Agile Falcon in close cooperation with the U.S. Air Force Aeronautical Systems Division. The American company had eventually concluded that an even larger 400-ft² wing would provide far better operational capabilities for the Agile Falcon.³⁸

This divergence of wing sizes for the two fighters during 1988 had not particularly concerned GD or Pentagon officials at the time, if indeed they were even aware of it. However, with the cancellation of Agile Falcon funding in April and, more important, the enormous emphasis that administration supporters of the deal had placed on potential benefits to the United States from the FS-X program during the congressional debates, at least some Pentagon officials felt obligated to revisit the question of developing a common wing for the two programs. Direct utilization of the FS-X wing would be a highly visible symbol of flowback of Japanese technology for a critical Congress. As one DoD official told a journalist at the time, "we're only involved in the military feasibility of this thing, but the potential *political* gains are quite easy to envi-

³⁸It will be remembered that the existing standard F-16 wing has an area of 300 ft².

sion." Another administration official was quoted as predicting high-level support for the initiative because of the "immensely positive political, military, and commercial implications."³⁹ The problem, however, was convincing the Japanese to drop their existing 375-ft² indigenous wing design and accept the larger 400-ft² wing to be designed in common for both the Agile Falcon and the FS-X.

DoD officials expected Japanese resistance to the idea of developing a larger common wing. They may not, however, have anticipated the opposition their proposal generated in the U.S. Air Force. Senior Air Force officials argued that, in the immediate aftermath of the bruising congressional debate, the Japanese would resent and strongly resist any U.S. attempts to force a change in their existing wing design. They feared that such a request from Pentagon officials could blow up into another major dispute further disrupting the program and could even lead to a resurrection of the whole FS-X issue in Congress.⁴⁰ It also seems that some Air Force officials felt little regret over the demise of funding for the Agile Falcon program. With continuing downward pressure on the procurement budget, a principal Air Force objective was to protect the ATF program from the budget cutters. One way to protect ATF was to eliminate other programs that could eventually make demands on scarce budgetary resources and that might be perceived by some as possible alternatives to the costly ATF.

As a result of these objections, U.S. officials decided to present the Japanese with the general results of GD and Air Force technical trade-off studies showing the superior performance of the new 400-ft² wing design over the earlier 375-ft² design but to avoid the appearance of pressuring the Japanese to adopt the larger wing. This was done at the first TSC meeting in late August. The Air Force director of engineering for the F-16 presented a briefing that demonstrated that the larger wing provided significantly improved performance for anticipated U.S. Air Force missions and incorporated major improvements in structural design and system engineering. The American side emphasized, however, that this briefing was being presented solely for the information of the Japanese representatives and not as an attempt to influence the FS-X de-

³⁹Both quotations from Amouyal (1989), pp. 1 and 7. Emphasis added.

⁴⁰Interview with a U.S. Air Force officer, April 11, 1991.

sign. The Japanese expressed appreciation for the additional information but showed little real interest in adopting the enlarged American design. Some on the American side believed the Japanese had already reached consensus on what their engineers viewed as the optimal design for the FS-X wing and saw no reason to further disrupt the program by radically changing the design. Others speculated that the Japanese never intended anything other than developing their own wing design, and after the traumatic experience of the bitter debate in Congress the previous spring, they would oppose adoption of a new American wing design as a matter of principle.⁴¹

One of the primary reasons some Air Force officials opposed pressuring their collaboration partners on the wing issue stemmed from persistent indications of continuing Japanese sensitivities over the issue of reexport of wing technologies to third parties and use of those technologies on other American defense programs. Yet despite sincere efforts by most officials on the American side to avoid further problems and finally to launch the R&D program, the old issues of classification of the wing technology and reexport of derived technology to third countries nonetheless reemerged in the late summer and fall as a serious and disruptive dispute. These same problems had contributed to a delay of at least six months in signing the original MoU in the last half of 1988. Indeed, the question of third-country technology transfers had been a major stumbling block in the Pentagon quest for Japanese technology going all the way back to the beginning of the 1980s. Once the Japanese finally signed the MoU in November 1988, the American side believed the issue was finally resolved. But even following the signing, Japanese press accounts had predicted that serious political opposition would still arise in Japan to the American insistence on the unrestricted right to reexport derived military technology to third countries, because such a right was perceived as a violation of the Japanese prohibition on arms exports.⁴² This problem had been overshadowed throughout the first half of 1989 by the Bush administration's quest for MoU clarifications on workshare and technology transfer to Japan and by congressional attempts to

⁴¹Interviews with a U.S. Air Force officer, April 11, 1991, and a senior U.S. industry official, August 4, 1992.

⁴²For example, see "Diet to Vigorously Scrutinize FSX Accord" (1988).

block or radically modify the FS-X deal. Once the issue of congressional approval had finally been settled in September, these problems returned, to the great consternation of the American working-level officials on the program.

Renewal of the Dispute Over U.S. Access to Wing Technology

These problems reemerged in the context of yet another series of negotiations for a new program document launched by DoD in the spring. Negotiation of a Memorandum of Implementation had been anticipated all along to work out the more specific details of the program. The clarification crisis vastly increased the political importance of such a document. Negotiation of this document would provide the crucial implementation details of the general understandings reached during the clarification process about more-precise definitions of the derived and nonderived categories of technologies, as well as U.S. access to and use of such technologies.

In the early fall, a U.S. team led by the Pentagon's DSAA and the DoC left for Japan to begin negotiations with JDA and MITI representatives on what eventually came to be called the Memorandum of Implementation and Agreement (MOIA). The U.S. team aimed first and foremost to win written assurances that the Japanese section of the JMTC would not block the transfer of any indigenous military technologies sought by the United States throughout the lifetime of the program. The Americans also wanted to codify the clarification that all FS-X technologies other than the four major Japanese avionics subsystems would be considered derived technologies, at least at the beginning of the program, and to add wording that would require the Japanese to transfer the technology in a timely manner. However, the Americans had also agreed to establish general procedures to permit the Japanese to request a change of classification of a technology from the derived category to the nonderived category as the program progressed and as the technology content of specific items became clearer. Finally, the U.S. side wanted to clarify procedures for acquiring Japanese technologies MITI defined as nonmilitary and thus not subject to JMTC rules.⁴³

⁴³Interview with a senior DSAA official, August 6, 1992.

In a repetition of a pattern that was by now all too familiar, these negotiations did not proceed quickly or smoothly. They were dramatically complicated by the resurrection once again of the long-standing dispute, which had never been fully resolved, over U.S. access to and use of the composite-wing technology. Difficulties had arisen almost immediately following the arrival of the Japanese industry team in Ft. Worth at the end of June to begin negotiations on industrial details for the actual development program. Japanese government and industry officials raised numerous difficulties and problems that in effect would place restrictions on GD's access and use of the wing technology. As reported in the press, these problems initially centered on Japanese objections to unrestricted use by GD of the wing technology for other programs and for export to third countries. The dispute derived primarily from MITI's categorization of the wing technology as military, thus making it subject to Japanese restrictions on its application to other programs and on reexport to third countries based on the provisions of the 1983 Exchange of Notes governing the export of Japanese military technology to the United States (Schlesinger, 1989).

This dispute put the Americans in an extremely difficult position. Many of the most contentious aspects of the debate in Congress had been over U.S. access to Japanese technologies. In their effort to convince Congress not to block the program, administration officials had emphasized the potential benefits of unrestricted access to Japanese technologies, particularly those related to the composite wing. Compromising on this issue risked reigniting the debate in an already hostile Congress. It is not surprising, then, that one knowledgeable observer insisted "the resolution has to take place on the Japanese side . . . [the Americans] aren't renegotiating the thing."⁴⁴

In addition to the question of reexport of the wing technology to third countries, a second and related dispute soon emerged during ongoing discussions between GD and MHI. During these discussions, it became clear that MHI expected GD to pay a "technical guidance" fee for the transfer of any wing technology it intended to use on other programs such as Agile Falcon. The Japanese argued that free and automatic transfer of the wing technology referred

⁴⁴Quoted in Schlesinger (1989).

only to the application of the technology to the FS-X program. They insisted that any other application required GD to pay a fee, in accordance with the provisions of the 1983 Exchange of Notes (Kamada and Koyanagi, 1989, p. 1).

The renewed battle over the wing soon reached an impasse that could have resulted in the early demise of the collaborative program. Domestic politics prevented the U.S. side from compromising. Secretary Cheney and a host of other administration officials had repeatedly testified to Congress that the FS-X accord assured free and automatic U.S. access to the composite wing and all other FS-X technology with the exception of the four indigenous avionics systems. Senior Pentagon officials, such as General Ronald Yates, had explicitly told Congress that GD would get the wing technology free of charge because the FS-X wing "is based on a U.S. wing design." (Kamada and Koyanagi, 1989, p. 12; also House, 1989b, pp. 45-46, 52.) Congress would raise howls of protest if it learned that GD would have to pay for wing technology. Yet MHI was equally determined not to give away technology without compensation for unrestricted use by GD that it considered to be proprietary information and that it had developed through the investment of considerable corporate funds. MITI appears to have indirectly supported this position by arguing that the technology could not be reexported without Japanese government permission, thus implying indigenous origin of the technology.

This fundamental disagreement over the wing technology, combined with the resentments and anger on the Japanese side in the wake of the brutal public dispute earlier in the year, vastly complicated the negotiations over the MOIA. The working-level officials associated with the *kokusanka* supporters had fought against the clarifications demanded by the United States the previous spring and deeply resented the outcome when the higher political levels forced them to accept all the American demands. Now they were continuing to resist the full realization of the concessions imposed on them by the political levels with the renewed dispute over the wing and the negotiation of the implementation agreement for technology transfer. The questions of reexport rights and fees for the wing were both part and parcel of the same fundamental problem directly related to the issue of technology classification under negotiation for the implementation agreement: The U.S. side insisted that the MoU and the clarification agreements

reached in May had designated the wing as derived technology for purposes of free and automatic U.S. access, while the Japanese still argued that the wing was indigenous military technology and thus subject to JMTC procedures.

Japanese Complaints About the Transfer of F-16 Data

This complex and convoluted dispute eventually caused another major crisis in the program requiring high-level government intervention to resolve. Yet, initially, the Japanese held firm to their position and even launched a full-scale counterattack with their own list of major grievances about technology transfer. By the fall of 1989, U.S. officials began hearing a growing chorus of Japanese complaints about the transfer of F-16 data. Indeed, Japanese dissatisfaction with the pace of F-16 data transfer, and restrictions placed on those data, rapidly became a cause of major new frictions on the program. Following the Japanese payment of the first installment of the license fee, GD had sent the first batch of F-16 data to Japan in late July. A second batch arrived at MHI in September. However, Japanese industry considered these data to be nothing more than general and preliminary background information of little use for their detailed design work. One newspaper account characterized them as "on the level of nothing more than elementary technology."⁴⁵ Japanese industry wanted to begin full-scale development in October but argued that the slow transfer of F-16 data would further delay this schedule.

Part of this problem stemmed from the enormous task of coordinating and implementing the review of all F-16 data prior to transfer to Japan, which had been assigned to a handful of overworked personnel at the F-16 SPO at Wright-Patterson Air Force Base. The F-16 TDP included approximately 8,000 technical drawings and 3,000 technical documents (GAO, 1992a, p. 26). The original FS-X MoU had promised transfer to Japan of the entire TDP, subject to deletions and modifications determined during the normal DoD review process and other specific restrictions negotiated in the FS-X deal. However, the huge controversy over transfer of F-16 technology to Japan that had blown up in Congress at the beginning of the year meant that this review process would be any-

⁴⁵"Independent Development of FSX, SSM" (1989).

thing but routine. With the GAO, DoC, and Congress looking on, officials in the Pentagon and the Air Force had to scrutinize every drawing and document with utmost care and thoroughness to make sure nothing was transferred to Japan that could possibly be perceived by Congress or the DoC as violating the spirit of the MoU or the clarifications. Although the F-16 SPO coordinated and consolidated this review process, many other government authorities were directly involved, including the DoC, DSAA, DTSA, and others. Some documents and drawings would be found to be not applicable or denied, while others had to be tailored for use in the FS-X program. Not surprisingly, this process proved to be painfully slow and inefficient. By the time of the first TSC meeting at the end of August, U.S. Air Force personnel estimated that review of the entire TDP would take at least eight more months.⁴⁶

This situation clearly displeased the Japanese. As mentioned above, they complained that the slow pace of data transfer further delayed the start-up of the project, already set back at least a year by the political controversy. They noted that MHI could not rationally plan its R&D activities until it knew exactly what F-16 data it would receive and what data would be withheld. And this problem could not be resolved until the U.S. officials, who included four full-time engineers, completed their review of all the data items.⁴⁷

On a more profound level, however, this whole dispute over the transfer of the TDP and the wing reflected the deep resentments felt by the Japanese working-level officials about what they perceived as the gross asymmetry in each side's access to the other side's technology. To many Japanese, access to U.S. technology appeared to be increasingly restricted and circumscribed. Furthermore, Japan had to pay for everything it got. And to add insult to injury, the Americans were taking nearly a year to transfer the data package, the exact content of which would not be known by the Japanese until the end of the procedure. Numerous U.S. government agencies and authorities were in the process of scrupulously examining each of the thousands of items in the F-16 TDP. This process had commenced after the interagency review in March had already formally removed a large number of technology areas from consideration for transfer to Japan, most significantly the

⁴⁶Interviews with U.S. Air Force officers, June 11, 1991.

⁴⁷"Independent Development of FSX, SSM" (1989).

flight-control computer source codes. Although the U.S. side ultimately determined that only a relatively small percentage of the total data items in the F-16 TDP had to be tailored for FS-X use or were not applicable to the program, the whole process seemed unfair and disruptive to many Japanese officials.

At the same time, the U.S. side was demanding with increasing stridency the free flowback of all derived data emanating from the program. Furthermore, American negotiators continued to insist on the right of full, free, and unrestricted access to all the wing technology, including total GD involvement in wing R&D. MHI, of course, had always considered the wing to be indigenous technology and, therefore, consistently argued that it should be categorized as nonderived. Equally unfair from the Japanese perspective, the U.S. side had insisted during the clarification process that all FS-X technology other than the four indigenously developed avionics systems had to be classified as derived, at least at the beginning of the program. Finally, the Americans had demanded strict assurances that the Japanese government would not block the transfer of any nonderived technologies sought by the United States and now wanted them codified in a new formal agreement. In short, it appeared to many Japanese officials that the Americans were demanding guaranteed access to virtually all new FS-X technologies, whether of U.S. or Japanese origin, and most of it for free, while increasingly restricting or limiting Japanese access to F-16 and related U.S. technologies.⁴⁸

In many respects, this whole new dispute was nothing less than a rerun of the same battles initially fought throughout 1988 during the negotiation of the MoU and then again during the clarification negotiations during the first part of 1989. Indeed, many of the elements of this dispute mirrored those first addressed in 1981 when the Pentagon began its quest for Japanese technology in earnest. Nonetheless, the dispute over the wing and the general technology transfer implementation agreement in the fall of 1989 became so heated that at one point the U.S. government blocked further transfer of F-16 technical data to Japan pending resolution of the issue. But this time MHI refused to budge from its position, and the Japanese government found itself either unable or unwill-

⁴⁸"Independent Development of FSX, SSM" (1989); interview with a U.S. Air Force officer, June 11, 1991.

ing to force the company to transfer the technology to GD without compensation.

Japanese Control over FS-X Design Formally Confirmed

Once again, continuing pressure from the United States, most notably characterized by the withholding of F-16 data, and the renewed specter of the collapse of the program and a serious deterioration in U.S.-Japan relations finally led the Japanese government to agree to the American conditions. In essence, JDA resolved the problem of fee payments demanded by MHI by giving in to *both* sides. In late December, the Japanese government informed U.S. officials that GD would receive all wing technology free of charge. At the same time, JDA agreed that it, and not GD, would pay MHI for any company-owned proprietary technology it transferred to the American company. The additional expense seemed a small price to pay to keep the program on track and prevent the FS-X issue from reemerging in the U.S. Congress.⁴⁹

The other aspects of the wing problem and the completion of the implementation agreement for technology transfer took somewhat longer to resolve. By early February 1990, it had become clear that the U.S. side would get most of what it wanted. Negotiators reached a compromise on the politically sensitive issue of GD use of the wing technology outside the FS-X program and its re-export that satisfied U.S. concerns. Officials refused to discuss the details of the final agreement, in deference to Japanese political sensitivities over the issue of military exports. But according to one knowledgeable participant quoted in the press, the final settlement was "completely satisfactory to the U.S. [and] there are no compromises from the U.S. standpoint." He went on to explain that GD could use the wing technology that "it anticipated having" as it saw fit, requiring only "perfunctory" approval from the Japanese government.⁵⁰ As several MITI officials later explained, the Japanese had agreed to treat the cocured composite technology as dual-use, but considered the wing design and unique tooling to

⁴⁹"Japan to Pay Mitsubishi for FSX Technology Sent to General Dynamics" (1982).

⁵⁰Quoted in Schlesinger (1990a).

be military technology and thus subject to special restrictions on reexport.⁵¹ The agreements signed at this time on the company level also explicitly required MHI to flow back without cost all FS-X technology to GD other than the specified nonderived subsystems and technologies.⁵²

The final form of the MOIA signed in late February 1990, after many months of negotiations between officials from DSAA supported by the DoC and JDA and MITI officials representing Japan, apparently also contained other key objectives originally sought by the Americans.⁵³ Since at least the 1988 MoU negotiations, the U.S. side had been concerned about potential problems of access to indigenous Japanese military technologies applied to FS-X because of the unwieldy JMTC mechanism and the power of the Japanese section to block transfer. Under pressure from Congress and the administration, the Japanese had agreed in principle during the clarification process to negotiate some form of blanket JMTC approval for transfer of all such technologies. This agreement appeared to have achieved that end. On February 20, the MOFA issued a brief statement confirming that the government had

[D]etermined that the FSX-related military technologies are appropriate to be authorized by the Japanese government for transfer to the United States government.⁵⁴

⁵¹Interviews with Japanese government officials, Tokyo, June 18, 1992.

⁵²Interview with a Japanese industry official, June 15, 1992. In the area of technology flowback, the GD-MHI agreements actually contained even stronger and broader provisions than the government-to-government agreements. According to industry sources, Japanese contractors were obligated to provide GD without cost *all* technology introduced into FS-X development, excepting only the officially designated nonderived Japanese systems or technologies. Unlike the wording in the government agreements, the industry agreements did not refer to this technology as essentially derived from U.S. technology. The more restrictive wording in the government documents would later cause problems when disputes arose over the actual derivation of certain technologies, as Japanese officials sought to avoid the requirement for free flowback on items they believed had been indigenously developed in Japan.

⁵³JDA classified this agreement, as well as all other FS-X agreements, after they were signed. This discussion is drawn from published newspaper accounts of the agreement.

⁵⁴Quoted in Schlesinger (1990b).

The agreement also apparently more clearly defined the concepts of derived and nonderived technologies as agreed to in the spring and spelled out to Congress by Joan McEntee, Deputy Under Secretary of Commerce, in her testimony at that time (see Chapter Eight). However, even this agreement did not fully complete the process of defining the terms of U.S. access to Japanese technology. An additional document on procedural details for U.S. access would still have to be negotiated at a later date, and once again this process would not prove easy. Finally, the MOIA explicitly required the "expeditious" flowback of derived technology after its introduction into the FS-X program. This wording was meant to strengthen the flowback provisions in the government agreements signed in 1988, which had dropped the wording calling for "automatic" flowback that had appeared in other MoUs for licensed-production programs.

As a concession to the Japanese, the new agreements clearly reconfirmed MHI as the project's lead contractor, with GD relegated to the same subordinate status as a secondary contractor similar to the other major Japanese participants: KHI and FHI.⁵⁵ Much more important, MHI's status as design leader was formally established. This concession had been granted in part because of friction between GD and MHI over design and development questions. As the developer of the F-16 and originator of the SX-3 design concept and proud of its decades of experience in fighter R&D, GD understandably assumed it would take a leading role in the design and development process for the FS-X. As one of America's premier fighter developers, GD was not used to accepting the subordinate status of a subcontractor. Yet, despite its lack of experience, MHI insisted on its prerogative of sole and undiluted project and design leadership, with all primary design activities concentrated at its Nagoya and other facilities (Schlesinger, 1990b). With Japan paying entirely for the program and the Pentagon having agreed several years earlier to MHI as the prime contractor, the American side could not really object to this arrangement. Nonetheless, this decision would have important consequences for the evolution of the program. It established MHI

⁵⁵IHI, which was expected to play a major role in the production program as licensed producer of the engine, would have a more peripheral role during the R&D phase, since the engines would be purchased directly from the U.S. supplier.

in a strong position to exercise considerable freedom of action independent of influence from GD or the Pentagon in the detailed design and development process. It permitted the *kokusanka* supporters to gain the maximum benefit from the program within the constraints of a cooperative development effort. It would ultimately doom DoD's efforts to control the design configuration and promote maximum commonality with the F-16 and Agile Falcon.

With the signing of these agreements, program participants anticipated a formal start of R&D about April 1, 1990. This represented a slip in the program schedule of about a year and a half from the launch date established when the original MoU was signed in late 1988. Even this earlier date represented a delay of at least a year from when the Japanese had originally hoped to begin development. Nonetheless, JDA had not altered the original schedule of first flight in 1993 and initial operational deliveries beginning in 1997. Many American observers believed the original schedule had been overly optimistic in the first place because it did not take account of the inevitable development problems always encountered in the complicated process of developing a fighter. With the additional 18-month delay caused by the debate in Congress, the MoU clarification process, and the negotiation of new detailed agreements, the original schedule seemed wholly unrealistic. Furthermore, many on the U.S. side felt that the apparent Japanese decisions to develop its own flight-control computer source code and exercise complete control over the design process could lead to further schedule delays and significant cost growth. Yet, at this point, the Japanese would not formally change the R&D schedule or program cost estimate. Some Americans worried that this could cause serious problems in the program down the road.⁵⁶

But perhaps most unsettling of all, the signing of the new agreements in February did little to dispel the widespread distrust and antagonism that had been engendered by the long public dispute throughout much of 1989 over the project, not to mention the preceding extremely difficult negotiations dating back to 1985. Even worse, with the basic program documents finally completed and signed, the senior political levels on both sides continued to leave implementation of the program in the hands of working-level

⁵⁶"Mitsubishi-GD Contracts Clear Way for April 1 FSX Start" (1990).

officials. On the Japanese side, this included key representatives of the *kokusanka* supporters who had never been happy with the imposition of collaboration with the Americans and who had been angered by the bitter congressional attacks and the demands for clarifications and new agreements. In mid-January, Shintaro Ishihara, the controversial Japanese nationalist author and Diet member, had characterized the FS-X deal in an opinion piece in the *New York Times* as follows (Ishihara, 1990):

The decision to jointly develop the FSX was forced down our throats What's in the current FSX deal for Japan? Nothing. We give away our most advanced defense technology to the United States but pay licensing and patent fees for each piece of technology we use. Washington refuses to give us the know-how we need most, attaches a battery of restrictions to the rest and denies us commercial spinoffs.

While Ishihara's views have generally been characterized as extreme and unrepresentative of the mainstream opinions of the Japanese political establishment, these sentiments on the FS-X accurately reflected the views of many Japanese working-level government and industry officials who, after a year of contentious debate in Congress and tough new negotiations with the U.S. side, were now charged with making the cooperative program with GD work.⁵⁷

On the U.S. side, implementation was left largely to GD and a handful of overworked Air Force officers, supported primarily by a relatively small number of working-level officials at DSAA, DTSA, and the DoC, not all of whom saw eye to eye on the major issues of program implementation. Unfortunately, the bewildering array of

⁵⁷Ishihara, a former Minister of Transportation, was the author of a highly controversial book entitled *The Japan That Can Say "No,"* which was initially translated into English under a Pentagon contract and read into the *Congressional Record* in November. In his book, Ishihara calls on Japan to break out of its subservient relationship with the United States and characterizes American policy toward Japan as tinged with arrogance and racism. This book was seen by many as indicative of the worsening economic and political frictions between the two countries. In January, Ishihara spent three days visiting U.S. officials in Washington. During a meeting with Secretary of Commerce Mosbacher, the American official reportedly told his guest that he hoped to write a sequel to Ishihara's book entitled *The Japan That Can Say Yes and Mean It.* See Farnsworth (1990).

memoranda, side letters, annexes, and implementation agreements that now governed the program still permitted wide latitude in interpretations, particularly in the areas of technology access. In many respects, the core disagreements over access to Japanese technologies had still not been adequately resolved, primarily because the two sides still viewed the FS-X in profoundly different ways. The Japanese remained intent on transforming the FS-X into the indigenous Rising Sun fighter, and therefore continued to resent the classification of most FS-X technology as "derived," particularly the wing. Why should Japanese technology used to develop an essentially Japanese fighter be treated as "derived" and handed over to the Americans free of charge? Given this difficult situation, it is not surprising that the program encountered numerous additional hitches and "mini-crises" in its initial phases.

THE RISING SUN FIGHTER REBORN?

INTRODUCTION

Detailed collaborative planning for the actual engineering development of the FS-X fighter did not really get under way until the beginning of April 1990, nearly a year and a half after the signing of the original MoU. By this time, the broad outlines of program management and work division had been established. Unfortunately, during the 14 months or so spent negotiating the original MoU and industry agreements and the ensuing months of contentious debate over the clarifications and technology transfer implementation agreement, little beyond these basic program principles had been worked out between the two sides. The specific details of the cooperative development effort still remained far from certain, at least from the American perspective. However, JDA and Japanese industry had continued to develop their own plans and technological priorities for the FS-X throughout this period and began implementing them as details of the R&D phase were hammered out.

Some of the consequences of the Japanese strategy became apparent during the first year of R&D, when a new controversy arose over unanticipated cost growth and schedule delays. For several months following the public acknowledgment of the problem late in 1990, rapidly escalating cost estimates appeared to put the continuing viability of the program once again in doubt. This was particularly true because the Japanese side began publicly blaming the cost growth and serious developmental program delays on American industry and actions of the U.S. government. Many Japanese officials complained that the FS-X would have been developed on

schedule and within original cost estimates if U.S. political pressure had not forced Japan to collaborate with American companies. The American side denied these allegations, but generally focused on smoothing over the dispute and preventing it from seriously disrupting the program.

After several months, the dispute over cost growth faded from the press. Adjustments were made in the program to compensate for increased costs, and the R&D effort continued. Nonetheless, this episode is extremely important for what it revealed about the evolution of the FS-X design and R&D effort. The dispute over cost growth certainly demonstrated that Japanese hostility over imposed collaboration and the ensuing clarification crisis still ran deep. But more importantly, it dramatically illustrated the full extent of the modifications and applications of new technology to the baseline F-16/SX-3 design that Japanese industry was carrying out. Trans-Pacific collaboration and the delays that the political controversy caused in the United States had clearly added to the original cost estimates for FS-X. However, as the U.S. Air Force revealed during the dispute, a major reason costs escalated over original U.S. industry estimates was that the Japanese made far more changes and additions to the basic design than American industry had proposed in the original concept of the program. To a large extent, the cost growth problem made evident the large degree to which the Japanese were succeeding in moving the cooperative FS-X program toward the original technology goals established for an indigenous fighter program.

The political fallout from the American domestic battle over clarification of the MoU encouraged a greater U.S. emphasis on restricting technology transfer. This emphasis promoted the further evolution of the program away from the original U.S. concept of a modestly modified F-16. This unintended outcome is evident in a second controversy that also arose in the early phases of R&D. In the summer of 1991, the Japanese requested data packages for the licensed production or modification of a large number of U.S. components and subsystems for use on the FS-X prototypes. Because of the political sensitivity surrounding the whole question of technology transfer, U.S. program officials decided to deny permission or severely restrict the transfer of data on most of the items, even though Japanese industry had already acquired data packages and produced nearly identical items on earlier licensed-production pro-

grams. This decision led to a further dramatic increase in the Japanese domestic technology content in the FS-X and provided a tremendous opportunity for the *kokusanka* supporters to promote the expansion of the R&D capabilities of the lower-tier supplier base in Japan for sophisticated military aerospace components.

The dramatic transformation of the FS-X that the Japanese carried out during the early phases of the program was largely ignored by the U.S. side. The political atmosphere following the bruising public debate over FS-X focused the attention of U.S. officials almost exclusively on economic issues relating to technology transfer and workshare. The eventual transformation of the FS-X proceeded with little comment from American officials obsessed with the political symbolism of technology reciprocity. This chapter relates the story of that transformation during the early phases of the R&D program.

CONTROVERSY OVER COST AND SCHEDULE

Following the signing of the final industry agreements in late February 1990, press accounts quoted Dr. Vernon Lee, GD's Vice President for Japan Programs, as acknowledging that "we're not 100% sure ourselves" about the scope of GD's work and other details of the program, "because we haven't actually participated with them in anything." He went on to admit that GD was not "that well informed about the details of what's going to happen."¹ GD and Japanese industry still needed to spend considerable time sorting out a myriad of details on work tasks, contracting arrangements, program costs, and numerous other nuts and bolts of the business of cooperative R&D between firms located halfway round the world from each other. The other major task during 1990 was renewing the transfer of the F-16 TDP, which had been halted the previous year. The two sides devoted much of their efforts throughout 1990 to these problems. In resolving these issues, a new controversy arose over cost estimates and program schedule.

GD's initial contracts from MHI, worth roughly \$140 million, covered "production of a technical data package and engineering drawings" to assist in defining the aircraft.² GD would manufac-

¹"FSX Uncertainties" (1990).

²"Mitsubishi-GD Contracts Clear Way for April 1 FSX Start" (1990).

ture some parts for the prototypes and develop some process technologies, but on the whole, the first contracts called for little hardware development. One of GD's most important beginning tasks was to develop detailed cost estimates for carrying out its assigned R&D work and to help in costing out the overall program. GD presented these cost estimates to MHI in March—an action that led to a series of events that ultimately resulted in the first major public FS-X controversy during the actual R&D phase.

Reports of Cost Growth and Schedule Slippage

Beginning in early November 1990, numerous press accounts in the United States and Japan began reporting that the FS-X program was again in serious trouble because of intense Japanese dissatisfaction with dramatic increases in program costs and major schedule delays, both of which the Japanese blamed almost entirely on the U.S. side. According to a prominent article in the *New York Times*, “delays, huge cost overruns, and technical problems” were “engulfing” the project, causing “new discord.” It claimed that “the ill will, technological compromises and conflicts left unresolved in last year’s debate have begun to take a toll.” (Sanger, 1990, p. C1.) The widely respected *Defense News* reported that “rising cost estimates may lead to the delay, and possible cancellation, of Japan’s next generation fighter plane” (Baker, 1990a, p. 1.) Similar accounts appeared in the Japanese press. Under the sub-heading of “No More Co-development,” the *Nikkan Kogyo Shimbun* complained that:

The U.S.-Japan co-development project, a product of compromise after much haggling, has encountered one problem after another, so much so that the people currently involved on the Japanese side have said that they do not want any more co-development aimed at beefing up JDA equipment.³

This new controversy had erupted soon after JDA conducted a thorough review of the FS-X program and its funding in October in preparation for the submission to the cabinet for approval of its next Five-Year Midterm Defense Plan for 1991 through 1995. Fol-

³“FSX Project Complications” (1991).

lowing this review, JDA revealed that the FS-X R&D program would cost considerably more and take significantly longer to complete than originally anticipated. According to press accounts, the original development cost estimate of ¥165 billion (\$1.25 billion at ¥132 to \$1) had roughly doubled, with the new published estimates ranging from ¥280 to 330 billion (\$2.1 to 2.5 billion). Planners now projected that each FS-X would cost at least ¥845 million, or \$64 million, well over twice the cost of buying an F-16 off the shelf. In addition, the time needed to develop the aircraft had also nearly doubled, with additions to the original 3.75-year schedule reported in the press as varying from 2 to 2.75 more years.⁴

These reports of cost growth were correct. However, many newspaper accounts were improperly comparing the original development cost estimate made in 1985 yen to current cost estimates in 1990 yen. Much of the cost growth was due to inflation. Furthermore, it should not have been surprising that the program schedule had slipped, given the delay of a year or more caused by the political debate during 1989. Nonetheless, a significant increase in the real cost of the R&D program—on the order of 50 percent—had indeed taken place. Cost growth of this magnitude is hardly remarkable for a complex military R&D program. What is particularly revealing about the episode, however, is the war of words that broke out between observers on both sides about the cause of the cost growth and who was responsible for it.

Japan Blames U.S. Government and Contractors for Cost Growth

As widely reported in the press, Japanese officials and observers blamed the United States and its imposition of collaboration on Japan for the cost growth and schedule slippage. In particular, they pointed to GD's increased cost estimates for its share of the work as the primary cause of the overall program cost growth. One of the most dramatic examples appeared in an interview in the *New York Times* with Seiki Nishihiro, the former JDA deputy director who had overseen the negotiation of the original FS-X MoU

⁴See, for example, "Agency Extends FSX Development 2 Years" (1990); Sanger (1990), p. C1; and "GD Applied Financial Lessons Learned from A-12 to FSX: Eaglet" (1990).

and who still served as a consultant to the JDA. Nishihiro complained that the cost growth and schedule slippage threatened the viability of the program: "The FS-X project itself has completely lost its effectiveness . . . there is the possibility that the project will evaporate into thin air." The principal cause of the cost growth, according to the Nishihiro, was that GD "has doubled its quote."⁵ Nishihiro's views were widely held throughout the Japanese security establishment. As one senior JDA official pointed out (Baker, 1990a),

The total cost presented by the U.S. company is no longer applicable. It is getting bigger and bigger, and we can't accommodate that money.

While few observers believed this new controversy would lead to the outright cancellation of the FS-X program, it nonetheless revealed how strong the resentments remained in the Japanese military R&D community over the imposition of collaboration on what most perceived as purely American terms. Industry and government officials pointed to the cost growth and schedule slippage on FS-X as proof of the wisdom of *kokusanka* and as an irrefutable argument against further collaboration with the United States. MHI officials once again asserted that Japanese industry could build the FS-X much cheaper on its own. In the words of one Mitsubishi official, "The Japanese work method is more efficient than the United States." (Baker, 1990b.) Another claimed that "we don't know why the U.S. side [cost estimate] is so high . . . [W]e can complete this program with a lower cost." (Baker, 1990a, p. 36.) Such claims raised concerns among U.S. officials that Japan was reevaluating its entire policy of weapon collaboration with the United States in light of the continuing problems with FS-X. Such concerns seemed to be justified when JDA refused an American offer at about this time to cooperate on the production of a new U.S. Air Force mis-

⁵All Nishihiro quotations are from Sanger (1990), p. C1. At the end of the interview, Nishihiro confirmed what many on the American side had long suspected, that at the height of the battle over clarifications to the MoU, he had urged Prime Minister Takeshita that "we should scuttle the whole thing." Takeshita had overruled him on political grounds to prevent further deterioration in U.S.-Japan relations.

sile.⁶ At the very least, according to one U.S. official, “we are discovering that last year’s arguments [regarding FS-X] are not over by any means.” (Sanger, 1990, p. C17.)

More Extensive Modifications as a Cause of Cost Growth

Many American officials involved in the program were particularly concerned about this controversy, for two reasons. First, they believed that the evidence clearly suggested that the United States was far from solely responsible for the cost growth and schedule slippage. Even more frustrating, they felt they had anticipated and warned the Japanese about some of the main causes of these problems long before and had been ignored. Still, the last thing American officials on the working level wanted to see at this time was another major dispute over the FS-X.

To defuse the public controversy before it got out of hand, Brig Gen Robert Eaglet, the U.S. cochair of the TSC, went public in an extensive interview with *Aerospace Daily* in December to explain the American side of the situation. He placed much of the blame on inflation, fluctuation in exchange rates, and delays caused by the 1989 political controversy. He correctly pointed out that the original program estimate of ¥165 billion was in 1985 yen and had assumed an exchange rate of ¥150 to the dollar. General Eaglet put the current program cost at “something like ¥280 billion” using a dollar value of ¥130, or near ¥330 billion using the earlier exchange rate. He explained that the program’s cost growth in real terms was actually under 60 percent.

However, General Eaglet insisted that U.S. industry was not the primary culprit behind this cost growth. Rather, he argued that, in addition to the other factors, the “technical scope” of the program had also significantly expanded from what the American side had originally anticipated, causing the development costs to go up.⁷

⁶The U.S. Air Force’s Advanced Medium-Range Air-to-Air Missile (AMRAAM). Japan had begun development of its own indigenous air combat missile earlier after having been denied licensed production of the AMRAAM when the American missile was still under development.

⁷“GD Applied Financial Lessons Learned from A-12 to FSX: Eaglet” (1990).

To bolster this last point, General Eaglet gave reporters a detailed account of the history of cost estimates GD had provided to the Japanese. In the latter half of 1987, GD presented TRDI with total cost estimates (using 1985 dollars) for developing its SX-2 and SX-3 fighter design proposals as part of its marketing effort. These estimates were considerably below ¥165 billion when changed into yen. They assumed (1) all development work would take place in the United States; (2) the only major aerodynamic airframe modification would be an increase of the wing area from 300 to 375 ft² (to Agile Falcon wing standard); (3) all subsystems and components would be identical to the F-16, with the exception of the four Japanese avionics subsystems; (4) development would take 3.75 years; and (5) only two prototypes would be manufactured. At this time, MHI also had asked GD to provide "quick turnaround estimates" on the cost of stretching the standard F-16 fuselage by 10 in., slightly enlarging the nose to accommodate the MELCO radar, and changing the dorsal fairing for the Japanese EW suite. GD responded with general cost estimates for these tasks. Given the enormous uncertainties at that time about program structure, final design configuration, and so forth, the U.S. contractor apparently made a reasonable effort to provide as accurate estimates as possible.⁸

The most revealing aspect of this account is that GD had clearly provided development estimates for a *relatively modestly modified F-16 developed entirely in the United States*. This, of course, was precisely the type of program U.S. officials were seeking in 1987 as an alternative to a costly indigenous Japanese development program. TRDI, however, had taken GD's estimates and revised them upwards in accordance with its own more ambitious conception of the program. Its revised estimate included costs for Japanese development of a more extensively modified airframe, use of more advanced Japanese composites and structures, the addition of two more prototypes to the test program, extra costs associated with using an American firm as a subcontractor, and other factors. In accordance with standard Japanese practice, TRDI analysts excluded significant cost elements from their new

⁸GD Applied Financial Lessons Learned from A-12 to FSX: Eaglet" (1990); GAO (1992), p. 19. GD's estimates were not intended to be a formal response to a request for proposal, but rather a component of its marketing effort at the time.

estimate, such as the developmental and operational testing and evaluation and some other costs, because these items would be covered outside the basic TRDI FS-X R&D budget. The resulting estimate came in at ¥165 billion, about double the original 1987 GD estimate for developing the SX-3 in the United States.⁹ In 1988, Japanese industry conducted an independent costing exercise that confirmed the TRDI estimate. JDA then took the ¥165-billion projection to the prime minister, cabinet, and Diet, receiving formal approval for this amount as the official projected program cost.¹⁰

Interestingly, while TRDI's estimates nearly doubled GD's cost numbers for SX-3 development, they roughly matched the original TRDI and MHI cost projections for an all-Japanese fighter. In early 1985, MHI had estimated indigenous development of the Rising Sun fighter to cost about ¥200 billion. In September of that year, however, this estimate had been revised downward to ¥150 to 200 billion during the final review of the program before the anticipated government approval.¹¹ At least on the question of R&D cost, then, it appears that TRDI and Japanese industry saw little difference between indigenous development of an all-new Japanese fighter and cooperative development of a modified F-16. One could speculate that this similarity in costs reflected the *kokusanka* strategy of maximum modification and indigenization of the F-16 baseline fighter.¹²

Indeed, General Eaglet's explanation of the cost growth problem in late 1990 adds support to this hypothesis. In late 1988 and early 1989, GD and MHI had worked out the general allocation of specific work tasks within the context of the negotiations for the

⁹Translating GD's original cost estimate for the development of the SX-3 in the United States into a TRDI budgetary format reduced it by about 30 percent. TRDI's estimate was about double this number. Therefore, it is not unreasonable to assume that TRDI's 1988 estimate of ¥165 billion would be closer to ¥235 billion using GD's costing methodology. Interview with a U.S. Air Force program official, June 12, 1992.

¹⁰Interview with a U.S. Air Force program official, June 12, 1992.

¹¹See Chapter Five.

¹²Another theory is that the TRDI estimate for a cooperative program was constrained by the earlier overly optimistic estimate for indigenous development. Once collaboration had become the only option for FS-X development, so the theory goes, TRDI had to produce an estimate in the same range to make sure the program went ahead. Letter to author from a U.S. Air Force official, November 1, 1993.

industry-level LTAA signed in the second week of January 1989. The two companies agreed that GD would undertake the detailed design, development, and manufacture of a variety of parts and support equipment for the FS-X at its facilities in Fort Worth and in conjunction with the Japanese contractors at MHI's facilities in Nagoya. GD's tasks included designing, developing, and manufacturing the aft fuselage, the leading-edge flaps on the main wing, the stores management system (SMS),¹³ the avionics intermediate shop (AIS),¹⁴ and a software test station (STS). GD would also take part in developing the all-composite cocured wing boxes and in manufacturing two of the six sets intended for the R&D phase. At this time, GD had also been allocated some participation in developing the hardware and software for the flight-control system,¹⁵ as well as in selected avionics integration tasks. This work allocation reflected GD's assigned share of between 30 and 31 percent of the R&D budget. Most of the remaining portion of the U.S. mandated total share of 40 percent was expected to go to the U.S. engine manufacturer.

The primary Japanese contractors agreed to split up the work in Japan as follows: MHI, responsible for about 40 percent of the program by value, would lead the overall design, development, and integration of the fighter. It would develop and manufacture four wing sets in Japan. Final assembly of the prototypes, as well as the initial ground and flight test program, was planned to take place at Mitsubishi's facilities in Nagoya. KHI took responsibility for the center fuselage. Fuji would develop the nose, the tail assembly, and the upper main wing skin manufactured from composite materials. Ishikawajima Harima Industries (IHI) expected to maintain the engines bought off the shelf from an American firm for the prototypes and participate in licensed production of the en-

¹³The SMS is essentially an avionics computer system that assists the pilot in managing and employing various munitions, such as bombs and missiles, that can be mounted on the various "hard points" or attachment devices under the wing and the fuselage of the fighter.

¹⁴The AIS is a highly automated and sophisticated electronic test station used for maintenance and repair of avionics systems and components on the F-16.

¹⁵This task, of course, was later withdrawn during the clarification process due to concerns over technology transfer.

gine during the series-production phase (GAO, 1992a, p. 12).¹⁶ The program industry structure and the division of work tasks at this time are shown in Figure 10.1.

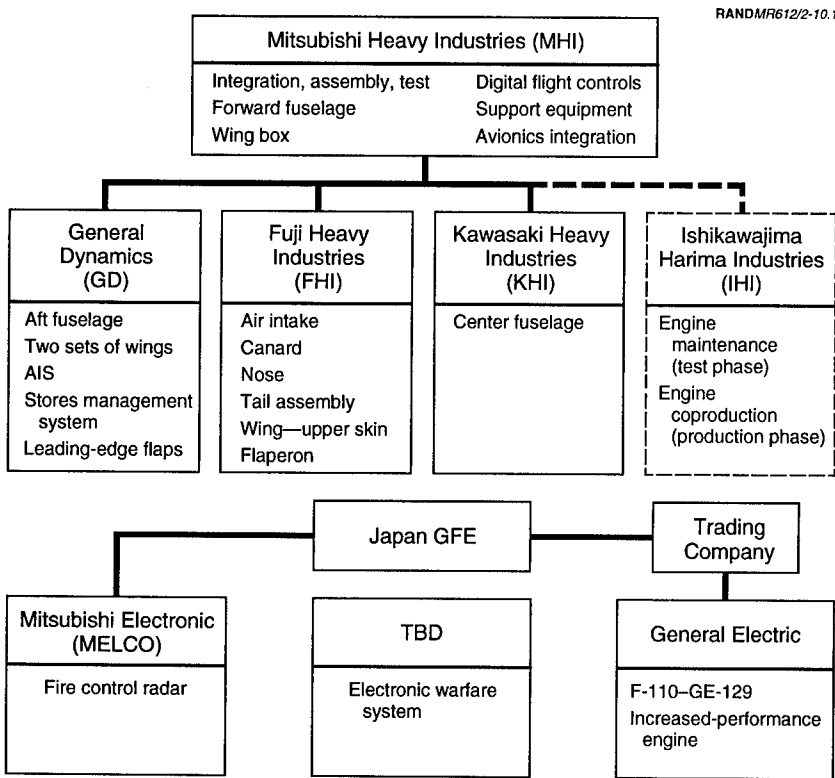


Figure 10.1—FS-X Industry Structure and Work Tasks in 1990

¹⁶On December 20, 1990, Japan announced selection of the General Electric F110-129 engine for the FS-X. Some U.S. observers speculated that JDA rejected the Pratt & Whitney entry—the F100-229 engine—because Japanese industry was already familiar with Pratt & Whitney engines through the F-15 licensed-production program and sought to learn more about the technology of the other major U.S. engine manufacturer, with which it had less experience. See “Japan Picks General Electric’s F110-129 to Power FSX” (1990).

General Eaglet later explained that, in the course of determining the allocation of specific work tasks in late 1988 and early 1989, MHI had issued its first detailed work statement to GD. MHI's work statement "revealed that they were thinking of a much different type of job for General Dynamics" than originally anticipated. In other words, GD began to realize that MHI wanted far more extensive revisions to the baseline design than the U.S. side originally had anticipated. General Eaglet claimed that GD had to spend several additional months developing revised cost estimates for its newly assigned specific tasks in response to the MHI work statement. The detailed GD estimate for its portion of the work, completed in August 1989, reflected a considerable increase in cost over comparable work in its original SX-3 cost projection because of the much more extensive modification work MHI now required. However, GD refrained from presenting its new cost estimate to the Japanese contractor in mid-1989 because Congress still had not settled the final status of the program, and contacts between the two firms had become minimal.

In March 1990, after the public FS-X controversy had quieted down and the final industry and government agreements had been signed, GD finally briefed its new cost estimates to MHI. But by this time, according to the general's account, TRDI and MHI had even more dramatically modified the technical content and schedule of the program. This became evident in July, when MHI issued a formal RFP to GD that included much more specific work packages and a revised statement of work. General Eaglet emphasized that the August work statement represented the first official detailed technical description of specific work tasks for GD. Furthermore, he stressed that the new work statement contained "significant changes" from the December 1988 work statement MHI had provided. The changes included such items as an all new SMS; new avionics remote interface units; an extensively modified AIS; "a lot more composites than had been previously assumed," including the aft fuselage and the leading-edge flaps; and "significant new integration efforts" by GD. As Eaglet pointed out, U.S. officials had originally believed the FS-X would not be "markedly different" from the F-16. "Now according to the current statement

of work," the general claimed, "it looks like 95% of the [engineering] drawings will have to be redone."¹⁷

If General Eaglet's account is accurate, its implications are dramatic. In essence, he argued that a significant cause for the upward revision in GD's projected R&D cost estimates flowed from the dramatically different conceptions of the program the two sides still held as late as 1989. To summarize, in 1987 GD had costed out several relatively modestly modified F-16 design concepts assuming development entirely in the United States, presumably in accordance with the Pentagon's general guidance at the time. TRDI had taken these estimates in 1988 and increased them by approximately a factor of two to reflect the much more ambitious modifications and applications of Japanese technology that it intended to incorporate into the fighter. The work statement MHI provided to GD in August 1990 called for R&D efforts that went significantly beyond those GD had anticipated. While using the F-16 as a general baseline, MHI plans now called for changing about 95 percent of the total engineering drawings and significantly changing most of the major avionics and other subsystems and support equipment, all of which amounted to much more than the relatively modest modification of the F-16 that the Pentagon had originally anticipated. While retaining a superficial resemblance to the F-16, the FS-X the Japanese envisioned would in many respects be an all-new fighter. Thus, it appeared that, while Congress and U.S. officials had been busy fighting over clarifying questions of technology transfer and workshare during 1989, TRDI and Japanese industry had moved the FS-X considerably further toward the conception of the Rising Sun fighter. The FS-X configuration as envisioned at this time and the major changes to the baseline F-16 design are shown in Figure 10.2.

Certain aspects of General Eaglet's account do not seem to be entirely accurate, at least in the area of composites applications. The SX-3 proposal GD made to the Japanese in 1987 had projected the use of composite materials for the wings and center fuselage, as well as "new technology throughout the remainder of the airframe." (Button, 1989a, pp. 42B, 42D.) The American contractor had

¹⁷All quotations from "GD Applied Financial Lessons Learned from A-12 to FSX: Eaglet" (1990).

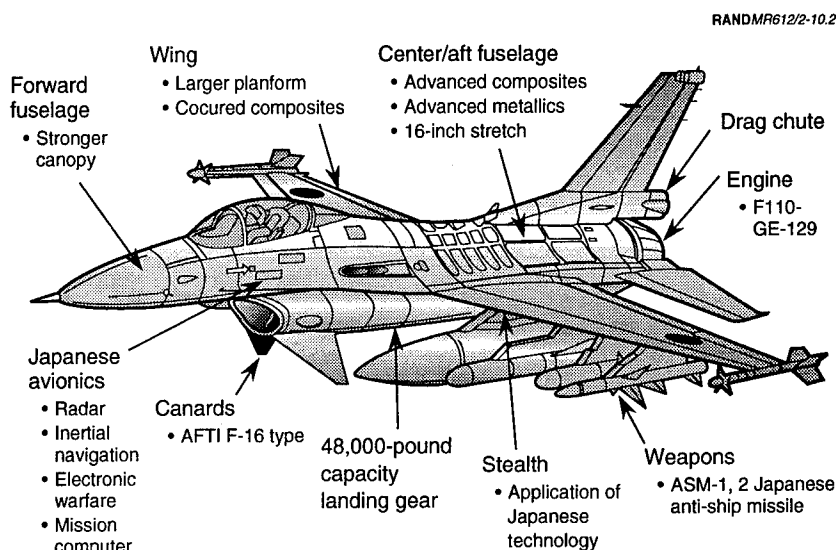


Figure 10.2—FS-X Configuration in 1990

discussed the extensive application of composites to the aft fuselage during its workshare negotiations with MHI during 1988, at least in general terms. On the other hand, GD's composite wing for the SX-3 envisioned a much more conventional metal substructure covered with composite skins, a significantly lower-cost and lower-risk approach than adopted by the Japanese with their all-composite cured wing. Given the lack of detailed program definition, its cost projections could only be expected to provide a rough estimation. Furthermore, GD also had little experience with developing major composite structures at that time. By 1990, the great difficulties it was experiencing engineering the composite structures on the Navy's A-12 attack aircraft program may have helped the American company generate a more realistic appreciation of the costs and technological risks associated with such structures.¹⁸

Some American program officials also dispute the accuracy of Eaglet's account as portrayed in the press. They point out that

¹⁸"GD Applied Financial Lessons Learned from A-12 to FSX: Eaglet" (1990).

MHI's work statements to GD covered only the company's five lead tasks, so GD could not have shown that "95 percent of the drawings" would have to be changed. They insist that most of the modifications called for in GD's five areas were, or should have been, anticipated, especially given the extensive modifications implied by the original SX-3 concept that both GD and the government had accepted. The increases in TRDI's R&D cost projections, they argue, were overwhelmingly the result of aspects of the program settled during the original MoU negotiations—a Japanese-led cooperative development, a joint design team in Nagoya, development of the cocured wing and manufacture in both countries, additional prototypes, and so forth.¹⁹ Some observers also believed that GD was partly responsible for the whole episode by providing unrealistically low initial estimates to help win the original competition with McDonnell-Douglas.

This debate cannot be resolved without access to government and industry documents that are not available to the public. But one key point apparently remains beyond dispute. By the end of 1990, the FS-X would clearly be changed far more significantly from the baseline F-16 design than the American government, or at least Congress, had originally assumed. In reference to General Eaglet's account, one program official explained that:

Throughout the 1990 time-frame the general thinking of the U.S. was that the FS-X would be an "ECP" [an engineering change proposal, which is generally a relatively modest modification] to the F-16 block 40 to incorporate the generally identified modifications. Over the course of 1990 it was recognized that MHI intended to use the transferred F-16 TDP as reference data rather than as a basis for a large ECP.²⁰

The 1989 Debate and the Evolution of the FS-X Design

The clear implication is that MHI would use the F-16 design as reference data for its own design excursions and experimentation. Whatever the primary cause of the cost growth, most observers seem to agree that, by 1990, the U.S. side realized that the pro-

¹⁹Letter to the author from a U.S. Air Force official, November 1, 1993.

²⁰Letter to the author from a U.S. Air Force official, November 1, 1993.

gram had been transformed into a much more extensive modification effort than the Pentagon had originally intended. Yet, remarkably, General Eaglet's revelations about this transformation caused hardly a stir in the United States. Instead, all attention remained focused on assuring the 40-percent workshare won in principle by the United States, controlling F-16 technology transfer to Japan, and gaining access to Japanese technology. The American side consistently tried to downplay the emerging controversy over cost growth, while justifying GD's cost estimates as a means of protecting U.S. workshare. At the same time, most Japanese working-level officials avoided the whole question of changes in the ambitiousness of the development effort and instead used the issue of cost growth primarily as a means to criticize collaboration with the United States and to justify their continued advocacy of indigenous development.

One important explanation for this phenomenon is that the 1989 debate had completely changed the dynamics of the program for the American side and shifted the incentives influencing the U.S. working-level officials who implemented the program. Following the congressional debate, Congress had directed the GAO to audit the program almost continually and to provide full-scale progress reports every six months. These audits centered almost exclusively on monitoring the transfer of F-16 and related technology to Japan and on access to Japanese technology. This situation encouraged U.S. Air Force personnel to devote a considerable amount of time and resources to this question, as well as to workshare issues.²¹ The enhanced role of the DoC had a similar effect. DoC officials, who were also primarily concerned with these same issues, were now fully involved in the program, including permanent representation on the TSC. Officials at DTSA and DSAA adopted a particularly activist role, with a heavy emphasis on monitoring and controlling the transfer of U.S. technology to the Japanese side.

²¹Air Force officials believe they would have been just as diligent in controlling the release of technology without GAO oversight. However, they believe GAO involvement required them to develop better-documented procedures to provide a clear audit trail for GAO investigators. They also note that they stressed workshare issues because adjustments in work allocation would be more difficult later in the program. Letter to the author from a U.S. Air Force official, November 1, 1993.

Thus, the political and institutional environment following the congressional controversy was overwhelmingly oriented toward technology transfer, workshare, and other economic issues. DoD and the U.S. Air Force, seeking to repair the damage wrought by the public controversy to the U.S.-Japan security relationship, had little incentive to risk provoking new controversies over questions of design and configuration of the FS-X. Furthermore, the program documents granted them no real authority to intervene decisively in these areas. Their main objectives were to keep the program out of the headlines, make it work smoothly, and satisfy Congress and the DoC about the progress being made on the workshare and technology-transfer provisions.

The continuing controversy over the development of the flight-control system software aptly illustrates how the dynamics of the program had changed after mid-1989. During the U.S. government interagency review in February and March, DoD and DoC officials had agreed on the necessity of explicitly denying Japanese industry access to the source codes for the flight-control computer because of concerns over the possible commercial applicability of this technology. Yet this decision, made on general economic grounds, served the needs of the *kokusanka* supporters who sought to build up Japanese indigenous capabilities in military technology. Confronted with the options of either buying black-boxed source codes off the shelf from GD or indigenously developing their own at considerable additional cost in time and money, the *kokusanka* supporters chose the latter course (see Chapter Nine).

In 1989, American government and industry officials had urged the Japanese repeatedly to purchase U.S.-developed source codes for the flight-control computer instead of developing their own, to avoid possible major cost increases and schedule slippage in the overall development program. Ironically, once such problems actually emerged in December 1990, Japanese officials used the source code issue to criticize collaboration with the United States. As one article at the time pointed out, "Blame for the FS-X's runaway costs is being heaped on the Americans. It is all their fault, say the Japanese, for refusing to hand over the F-16's 'source code.'"²² Instead of pointing to the wide array of ambitious Japanese technology applications—many of which U.S. officials

²²"Japan's FS-X Fighter: Wings of Desire" (1991).

had warned against for cost reasons since 1986—and the major modifications to the baseline F-16/SX-3 that MHI now planned as at least partially responsible for the cost growth and schedule delays, Japanese program officials blamed GD and the Americans.

U.S. officials readily accepted some responsibility for the problems. Clearly, the 18-month delay in program launch that the clarification process caused added to cost and schedule slippage. The requirement for GD to manufacture two of the wing sets in Fort Worth meant that the Japanese had to pay for two separate sets of the extremely costly tooling for the construction of only a total of six wing sets and a handful of other structural test articles. Program agreements also required the Japanese to pay for a variety of collaboration technology-transfer costs, including the summarization and translation of technical documents for U.S. examination and the expense of supporting U.S. Air Force personnel monitoring the program at Wright-Patterson Air Force Base and in Japan.²³ These included one liaison officer at MHI Nagoya and one at the Japanese FS-X program office at TRDI in Tokyo. The Air Force had also established a small FS-X program office within the F-16 SPO at Wright-Patterson Air Force Base and designated a program monitor on the staff of the Secretary of the Air Force.

But there seems to be little doubt that the extensive modifications and the application of new technologies to the standard F-16 baseline design the Japanese planned were important causes of cost growth. Beginning in 1986, Pentagon cost analysts had warned the Japanese that their cost estimate of ¥150 to 200 billion for the development of an indigenous fighter had been understated by a factor of at least two to three, particularly given the cutting-edge avionics and the advanced composite applications to the wing and other parts of the aircraft structure. Much of the high-cost, high-risk technology originally planned for the Rising Sun fighter was now being applied to the heavily modified collaborative FS-X. JDA planners themselves calculated that using the F-16 as a baseline would only save about 25 percent in development costs compared to an indigenous fighter because of the extensive modifications planned.²⁴ The revised cost estimate of around ¥280 billion General Eaglet reported in late 1990 is consistent with the cost

²³“GD Applied Financial Lessons Learned from A-12 to FSX: Eaglet” (1990).

²⁴Interviews with U.S. Air Force officials, June 11, 1991.

growth projected by the American analysts for an indigenous fighter minus the savings anticipated by the Japanese by basing the FS-X on the F-16.²⁵

Perhaps the most telling piece of evidence that the ambitious technological content of the program, rather than solely GD and the American government, was primarily responsible for driving up costs can be found in the escalation of Japanese industry's own estimates for cost and schedule. Based on a U.S. Air Force assessment, GD's 1990 cost projection, derived from MHI's more detailed work descriptions and tasking, represented an 87-percent increase over its 1987 estimate using the SX-3 proposal. However, GD's higher cost reflected only 28 percent of the total program cost growth. Comparing the same two periods, MHI cost estimates grew by 72 percent, representing 38 percent of the overall program cost growth.²⁶

GAO concurred with this interpretation of the cost-growth problem. It concluded in its 1992 assessment of the program that "costs have escalated primarily because of design and configuration changes to the aircraft that were not included in the 1987 estimate." (GAO, 1992a, p. 3.) Thus, both the decision to extend the development program from 3.75 to 6.5 years, along with the increase in both GD's and MHI's cost estimates, seem to indicate a more realistic assessment by both contractors of the challenging technical demands now facing the developers of this largely all-new fighter broadly based on the F-16.

The Politics of Cost Growth

Nonetheless, blaming the cost growth primarily on GD and the American government served several purposes for the Japanese program officials. As one U.S. industry official told a reporter, the original Japanese estimate of ¥165 billion "is a mythical figure, but has become a standard with political reality behind it." (Baker,

²⁵The original cost estimate of ¥150 to 200 billion multiplied by 2.5 gives ¥375 to 500 billion. Subtracting 25 percent results in a range of ¥281 to 375 billion.

²⁶Interview with a U.S. Air Force program official, June 12, 1992. Also see GAO (1992), p. 3. It is unclear how much of MHI's cost growth is attributable to the need to develop its own flight-control computer sources codes. However, MHI had initially claimed that this would add only about ¥20 billion to overall costs. See "Japan's FS-X Fighter: Wings of Desire" (1991).

1990a.) The cabinet and Diet had formally approved this estimate, making it difficult for JDA officials to request a revision. This was particularly true in the tough new budgetary environment JDA and the Japanese defense industry faced. With the winding down of the Cold War and the prospect of improved relations with Russia, downward pressure on the Japanese defense budget had begun to mount. The 1991-1995 Midterm Defense Plan approved by the cabinet in December 1990 called for modest annual increases of about 3 percent per year. However, the new plan envisioned a significant decline in the share of the defense budget allocated to equipment procurement and military R&D. With TRDI's total five-year R&D budget projected to fall in the range of ¥500 to 600 billion, rising costs on the FS-X would clearly make it by far the largest project in the TRDI budget, accounting for half or more of all military R&D spending. Such large expenditures on a single R&D effort would crowd out funding for numerous other planned programs. Furthermore, the new five-year plan called for a comprehensive government review of spending levels three years into the program. Many observers expected defense funding to be further cut at that time, with the heaviest reductions again falling on military equipment and R&D. Blaming the American side for the cost growth served as a convenient political cover to help protect FS-X funding in this increasingly tight budgetary environment (Usui, 1991a).

Passing the buck on cost growth also helped protect several notions routinely advanced by the *kokusanka* supporters as rationales for expanding indigenous development of weapon systems. Foremost among these was the claim that Japanese companies could develop high-technology weapons tailored for Japanese requirements at less cost than American systems. TRDI and Japanese industry had always tended to discount American warnings that they were underestimating the cost and complexity of indigenous R&D, attributing the higher U.S. cost estimates to such factors as inflated American labor rates and inefficiencies in the U.S. acquisition system. Confronted with the predictable cost growth associated with any effort as technologically ambitious and complex as FS-X, the natural inclination of the *kokusanka* supporters was to place the blame on the Americans. The Japanese working level could then argue to the political leadership that, had

Japan chosen to go down the preferred path of indigenous development, the extra costs of dealing with the Americans and duplicating production facilities at GD could have been avoided, thus bringing R&D costs down into the original range of ¥150 to 200 billion.

Yet when confronted with the new budgetary realities and the political impossibility of canceling the program so soon after the bitter political dispute over clarifications, JDA had to take some action to control cost growth. In late 1990, JDA asked the contractors to reexamine their development plans to avoid any cost increases in excess of ¥100 billion over the original ¥165 billion (1985 yen) base-year estimate. In December, GD's president reportedly visited Japan for consultations with JDA on this issue. According to Japanese press accounts, GD and Japanese officials finally settled on a new official development estimate of about ¥250 billion (1985 yen), or ¥330 billion current yen. This represented an increase of just over 50 percent in real terms from the original cost estimate. It appears that officials considered transferring some work back from GD to MHI at this time as part of the required cost-cutting measures.²⁷

Indeed, another critical reason both sides exhibited such great sensitivity over the question of cost growth was its direct implications for the politically sensitive issue of workshare division. Many U.S. officials had difficulty understanding Japanese military R&D budgeting conventions. For years, American officials had expressed great skepticism about the realism of Japanese cost estimates. Many on the U.S. side suspected that TRDI's FS-X budget and other identifiable FS-X line items did not reflect the true total cost of developing the new fighter and its major subsystems. Some U.S. representatives, along with academic experts on the Japanese defense industry, believed that Japanese contractors—with tacit TRDI approval—spent a considerable amount of their own corporate funds during R&D, expecting to recoup their losses during production.²⁸ The view became widespread at the U.S. working level that the American government did not know, and would never find out, how much FS-X development really cost the Japanese

²⁷"FSX Project Complications" (1991).

²⁸For example, see Alexander (1993).

government and industry.²⁹ Yet the MoU only required allocation of 40 percent of the *official* FS-X budget to U.S. industry. If the official Japanese FS-X budget did not reflect the true total costs of development, then U.S. industry could be shortchanged on workshare. Many on the U.S. side came to believe that it had been a serious blunder to base the division of work on a percentage of the official development *budget*, as opposed to actual development *costs*. As one American official complained, it was very difficult to guarantee that U.S. contractors receive "a fictitious percentage of a fictitious R&D budget."³⁰

Placing the blame on the American side for program cost growth potentially had favorable workshare implications for Japanese industry. If TRDI did not admit an increase in the overall official development budget and if GD's cost estimates for its work tasks rose, then, in principle, work had to be shifted from GD to Japanese contractors to keep U.S. industry's share of the official development budget from rising above 40 percent. Apparently, however, no transfers of work actually took place at this time.

Ultimately, U.S. working-level officials decided not to dispute the question of actual total development costs with the Japanese government. The MoU had referred only to U.S. workshare as a percentage of the official FS-X budget, not to actual development costs. In addition, the Japanese continued to complain that they did not understand GD's revised cost estimates and asked for a detailed accounting from the U.S. contractor, as well as an independent U.S. Air Force assessment. But American officials concluded that a new battle over these issues would inevitably seriously disrupt the program. It would be difficult if not impossible to verify actual Japanese costs, or even the validity of GD's estimates. Instead, the American side sought to retain the bulk of the five main work tasks already assigned to GD and to encourage GD and the Japanese contractors to strive to bring down costs. This was essentially the course of action that both sides adopted in early 1991.³¹

²⁹Interviews with U.S. FS-X program officials, June 10–11, 1991.

³⁰Interview with a U.S. Embassy official, Tokyo, June 11, 1992.

³¹Interview with a U.S. Embassy official, Tokyo, June 11, 1992.

The Continuing Question of Cost Growth

Although the cost-growth controversy faded from the news for awhile, the basic problem did not go away. Indeed, it may have continued to worsen, although it is difficult to make any definitive assessment based on the publicly available information. The cost growth issue briefly surfaced again in June 1992, when GAO published an audit of the project that claimed (GAO, 1992a, p. 18):

[B]oth Mitsubishi's and General Dynamics' cost estimates have risen markedly. The U.S. Air Force estimates show that further cost increases are likely.

The GAO report also noted that "Japanese government officials declined to provide us with specific FS-X cost data," in part because "revised program cost data has not been provided to the Japanese Diet or the Japanese public." However, Japanese officials told the GAO investigators that "General Dynamics was primarily responsible for the increase," and that MHI's increases "were not significant." (GAO, 1992a, pp. 18-19.)

Japanese FS-X program officials objected to the GAO allegations of serious cost growth on the Japanese side, repeating the same arguments and assertions they had advanced in November 1990 when the problem first emerged publicly. Lt. Gen. Kiyoshi Matsumiya, head of air systems development at TRDI and cochair of the TSC, told reporters that "I know I'm not in a position to officially comment on the GAO report, but let me say it is unbearably untrue." (Usui, 1992b.) General Matsumiya admitted that development costs had risen an "unspecified amount," but blamed the cost growth on the duplication of effort and inefficiencies necessitated by GD's involvement in the program and on the U.S. denial of access to the flight-control computer software. Other program officials advanced the same explanations (Usui, 1992b).³²

Some American officials also rejected the impression left by the GAO report. First and foremost, they point out that, while the report came out in June 1992, it was based on information and views

³²Also see "What's Ahead in Aerospace" (1992); "FSX Cost" (1992).

gathered a year earlier. They insisted that the official budget still stood at the ¥250 billion (1985 yen) agreed to at the end of 1991.³³

Nonetheless, press accounts continued to report cost growth problems on the program. In August, *Defense News* reported that JDA would seek ¥90 to 100 billion for the FS-X in its 1993 fiscal year budget, up from ¥76 billion in FY92 (Usui, 1992c). It claimed that "if the 1993 request is approved, overall FSX development costs would rise to nearly 400 billion yen (\$3.17 billion)." Indeed, JDA reportedly finally settled on the even higher figure for its FY93 FS-X budget request of ¥107 billion.³⁴

Regardless of whether cost growth remained a continuing problem, there is no doubt the relatively large overall cost of the program was causing increasing difficulties for JDA budget planners. By the end of 1992, press accounts began reporting that the Japanese government planned to pare back the current five-year plan dramatically, beginning with the fiscal year 1993 defense budget, a year earlier than originally anticipated. Even worse, 76 percent of the ¥580 billion in planned cuts spread over the next three fiscal years would be taken out of the equipment procurement budget (Sekigawa, 1993a). In the final fiscal year 1993 budget approved by the Diet in March 1993, the FS-X program was allocated ¥96.5 billion, slightly lower than the JDA request for ¥107 billion. Yet this amounted to a full 64 percent of the *entire Japanese military R&D budget* (Ebata, 1993, p. 461). At the same time, U.S. pressure on the Japanese was steadily mounting for including airborne warning and control (AWAC) aircraft based on the Boeing 767 in the fiscal year 1993 procurement budget. JDA officials complained that the purchase of an initial two Boeing 767 AWAC aircraft would cost nearly 40 percent of the entire annual aircraft procurement budget for all three military services. Many Japanese officials did not see the military need for these extremely expensive aircraft at a time of shrinking defense budgets. Some believed the government had "bowed to U.S. pressure on the

³³Letter to the author from a U.S. Air Force official, November 1, 1993.

³⁴See "FSX Cost" (1992); "Japan Boosts FSX Spending Even as It Asks for Low Growth Budget" (1992).

AWAC aircraft program, much as it did when scrapping plans to build an indigenous FS-X." (Ebata, 1993, p. 23.)

Since the revelation of the cost growth problem at the end of 1991, various press accounts had speculated that the huge share of the R&D budget taken by the FS-X program would force the Japanese government to scrap it and possibly replace it with a modified F-15J or F-18. Reporters quoted one "Japanese diplomatic source" as insisting that FS-X was "becoming a drain, and must be resolved in some way. Resolved can mean solved, or it can mean more than that."³⁵ Another journalist later claimed "Japanese air force officers are trying hard to banish rumors that the FSX fighter codevelopment program is falling apart."³⁶ Most Japanese and American observers agreed, however, that the great symbolic importance of FS-X to the U.S.-Japan security relationship would still prevent cancellation of the program, at least for the time being. Nonetheless, JDA officials now had no choice but to take drastic action to bring FS-X development costs under control.

While Japanese officials continued to blame the cost growth on GD and the forced collaboration with the United States, most expert observers now recognized that the increased costs stemmed at least in part from "technical problems" associated with the ambitious remaking of the baseline F-16/SX-3 design concept sought by the *kokusanka* supporters, and to some extent encouraged by GD. With GD's five main work areas essentially fenced off and protected for the time being by the actions of American program officials in early 1991, the program cost growth combined with the relentless downward pressure on the defense budget slowly forced the Japanese to reduce the extent of the planned modifications and new technology applications to save the program. Initially, Japanese program officials attempted to cut back the technological risks and costs associated only with the American contractor's lead work tasks. However, in an implicit recognition that the inordinate technological ambitiousness of the program was a major cause of the cost problems, the Japanese eventually had to turn their attention to their own contractors.

³⁵"Tokyo Defense Cuts May Spell More Trouble for FSX" (1991).

³⁶"Show Me" (1992).

The Effects of Cost Growth on "Quality Workshare"

The first indication of the effects of program cost growth on GD's workshare and work quality came shortly after the initial dispute over cost in late 1990. Throughout the first half of 1991, GD, Japanese industry, and JDA continued to negotiate over the detailed content of the work packages in an attempt to bring projected development costs down. GD managed to implement some small cost-saving measures for its five main lead development tasks. In consultation with MHI, the American company further reduced estimated costs on the AIS and the STS. But the first really significant change came over applying advanced composite materials to the aft fuselage and leading-edge flaps.

GD, as well as many Pentagon officials, had always viewed the prospect of using Japanese money to develop new technologies and processes with applications to other U.S. defense programs as an important potential benefit of the FS-X program. GD had hoped to win contracts from the Japanese for "quality work," particularly in composites, that would have direct application either to the Agile Falcon program or the Navy's ATA/A-12 development effort it was undertaking with McDonnell-Douglas. The Japanese planned to use relatively conservative epoxy-based matrix resin material systems³⁷ for their cocured composite wing, center fuselage, and the tail section. GD officials, however, sought greater experience in developing structures using a more advanced matrix system based on bismaleimides (BMI). BMI resin systems generally are more heat resistant than epoxies, with a glass transition temperature generally 100°C above the epoxies. Thus, they can be applied more extensively to high-speed supersonic fighter aircraft (G. Green, 1990, pp. 41, 44). GD engineers believed future U.S. Air Force and Navy fighters would require the use of advanced high-temperature BMIs and therefore hoped to gain more experience working with

³⁷Composite materials used for aerospace structural applications generally consist of carbon, glass, or aramid fibers embedded in an organic matrix resin system. The major matrix resin systems for advanced structures are epoxy, bismaleimides, polyimides, and thermoplastics. Fibers that have been preimpregnated with a resin matrix are called "prepreg." Aerospace manufacturers stack many layers of prepreg with the fibers pointing in different directions depending on the design, then heat them under pressure to form a composite structure. See G. Green (1990), pp. 39, 41.

these resin systems through the FS-X program. As a result, in 1990, GD provided detailed proposals to MHI for applying advanced high-temperature BMI composites to the aft fuselage and the leading-edge flaps it would develop for the FS-X.³⁸

The growing controversy over cost growth and continuing Japanese resentment over U.S. restrictions on technology transfer ultimately led TRDI to reject GD's proposal out of hand. At the end of 1990, TRDI began an extensive study of the technical feasibility and cost-effectiveness of GD's proposal. The Japanese requested additional data from GD on the F-16XL program to assist them in their feasibility study. Meanwhile, U.S. government officials became concerned that if GD applied advanced high-temperature BMI composites to the aft fuselage and leading-edge flaps, the materials technology could be transferred to Japanese industry and possibly violate the spirit of the MoU clarifications accepted by Congress. After several months of intense debate among Air Force officials and several government agencies, the U.S. side ruled that GD could go ahead and use BMI composites but that the technical data transferred to the Japanese had to be "sanitized." The TRDI technical feasibility study eventually concluded, however, that GD use of BMI would be considerably more expensive and technologically riskier than using conventional aluminum. Furthermore, the Japanese analysis determined that the weight savings of substituting BMI for metal would be marginal. Therefore, in March 1991, the Japanese rejected GD's proposal.³⁹

The TRDI technical feasibility study had determined that applying BMI to the aft fuselage would save only about 30 percent of the weight GD had originally anticipated. Furthermore, the study claimed that Japanese advanced epoxy composites were equal in strength and high-temperature performance to the BMI material GD had proposed, the implication being that the Japanese had no incentive about potential technology transfer to accept the increased risk and cost of GD's use of BMI composites.

U.S. technical experts did not independently verify TRDI's technical assessment of the GD BMI proposal. Nonetheless, the

³⁸Interviews with U.S. Air Force officials, February 28 and May 2, 1991.

³⁹See "FSX Update" (1991).

worsening problems with overall FS-X cost growth and the Japanese view that GD was primarily responsible for them undoubtedly heavily influenced the Japanese decision on BMI. At least one senior Japanese industry official claimed that the U.S. decision to restrict the transfer of technical data related to the use of BMI also played a critical role in the Japanese rejection of GD's proposal.⁴⁰

Whatever the principal reason for the Japanese decision, the net effect remained the same: GD lost a major area of "quality work" that it had long sought on the FS-X program. Instead of winning the opportunity to develop major structural components out of advanced BMI composites, GD had to settle for developing a conventional aluminum aft fuselage and leading-edge flaps that differed little in structure and materials from the standard F-16.

At least for the time being, however, Japanese companies successfully protected their quality work in composite materials. MHI and Fuji remained committed to developing the all-composite cocured wing, and Fuji continued its development of advanced epoxy composite structures for the FS-X tail section. KHI still planned to apply composite materials extensively to the center fuselage.⁴¹ Thus, the only piece of the fuselage on which GD had lead development was also the only piece that would be made largely out of standard old-technology aluminum.

The technological ambitiousness of the program and the resulting problem of mounting R&D costs did, however, begin to affect other important areas of Japanese quality development work. Following the rejection of the BMI proposal, GD, Japanese contractors, and JDA continued their discussions on reducing development costs and establishing a final and definitive development cost estimate. As discussed earlier, JDA sought to cap development costs at ¥250 billion 1985 (¥330 billion 1991).⁴² As Japanese officials continued to review the technology demands and requirements for FS-X, they soon realized that even this larger figure might be insufficient.

⁴⁰Interview with a Japanese industry official, June 15, 1992.

⁴¹"FSX Update" (1991).

⁴²"FSX Update" (1991).

Dropping the Maneuvering Canards

To keep total expenditures under this ceiling, JDA realized that additional reductions in technological risk had to be sought. Emerging design problems and the increasing recognition of the magnitude of the technological challenge of developing computer software for the flight-control system of an advanced CCV fighter led JDA experts to reexamine the planned use of the two vertical chin canards underneath the fighter's air intake. As the detailed design work progressed, engineers also became increasingly concerned about growth in the projected weight of the airframe.⁴³ In addition, a problem with the aircraft's center of gravity migrating too far aft also apparently emerged. Finally, press accounts reported that MHI technicians were experiencing significant difficulties developing the complex flight-control computer source codes, a task made considerably more demanding by the incorporation of sophisticated CCV capabilities into the fighter's control system.⁴⁴

By late 1991, Western aerospace journals reported that Japanese technical experts had determined that elimination of the two chin canards could save considerable weight in the airframe and ¥500 million in development costs. Furthermore, these accounts claimed that such an action would reduce the complexity of developing the flight-control computer software. Following a major program review in December, JDA officially announced the elimination of the maneuvering canards from the FS-X design.⁴⁵

MHI and TRDI officials firmly denied that technical difficulties with incorporating CCV capabilities into the flight-control system and problems with airframe weight growth had led to the decision to discard the maneuvering canards. The Japanese argued it was a

⁴³Many aspects of a fighter's performance, such as acceleration and range, are affected by the ratio of the engine thrust rating to the overall operational weight of the aircraft. If the weight of the airframe increases beyond design goals during development and the engine thrust rating remains constant, operational combat performance may suffer. Some U.S. program officials at this time believed the FS-X was becoming far too heavy given the available thrust from its single engine.

⁴⁴"Japanese Aerospace Industry Faces Turning Points in Military, Civil Programs" (1992). Some U.S. program officials claim that no technical problems existed. However, they note that DoD—as well as GD—had always argued that the canards were not needed to meet FS-X operational requirements and that they did not provide significant operational utility.

⁴⁵See "Japanese Trim Foreplanes from FS-X" (1991–1992); "Japan to Drop FSX Canards to Save Weight, Money" (1991).

simple issue of cost-effectiveness. One MHI expert claimed that "we can achieve almost the same [performance] effect as the canards by enlarging the flaps and the wings a little."⁴⁶ Indeed, GD engineers had warned Japanese contractors since the beginning of the program that the performance improvements gained with chin canards on the T-2 CCV technology demonstrator were not necessarily transferable to the SX-3 design concept and that such an approach was neither a cost-effective nor a technologically desirable means of achieving the required CCV maneuvering capabilities for the FS-X.⁴⁷ Mitsubishi officials also insisted that development of the flight-control system was progressing well, in part because it was being based on the less complicated triplex system developed for the T-2 CCV program. Whatever the reasons for the Japanese decision, the problems with cost growth and the overall complexity of developing the flight control software are likely to have played significant roles.⁴⁸

Scaling Back Other Work Tasks to Save Costs

Dropping the maneuvering canards, however, did not eliminate the problem of cost growth and the resulting questions of possible reallocation of assigned R&D tasks to achieve the mandated national percentages of the official R&D budget. In July 1991, MHI finally awarded GD initial subcontracts worth about \$110.7 million to begin formal development work on its five assigned development areas: the aft fuselage, the leading-edge flaps, the cocured wing, the AIS, and various avionics and integration work primarily involving the SMS and the STS.⁴⁹ Combined with its initial design contracts and a license fee of \$60 million for the baseline F-16 design data, GD's program contracts now stood at over \$250 million. At this time, the American company expected the total value of its R&D program contracts to rise above \$800 million. Yet as actual development proceeded, GD found it increasingly difficult to meet

⁴⁶"Japanese Trim Foreplanes from FS-X" (1992); also see Ebata (1992) and "Quarrels, Conflicts in Tokyo Renew Threats to FSX's Future" (1992).

⁴⁷Interview with a senior U.S. industry official, August 4, 1992.

⁴⁸Interview with a U.S. Air Force official, June 12, 1992.

⁴⁹"General Dynamics Wins First in Expected Series of FSX Subcontracts" (1991).

its contractual responsibilities within its allocation of no more than 31 percent of the total budget of ¥330 billion.

By early 1992, GD's managers had become particularly concerned about burgeoning costs on the composite main wing and the AIS. At this time, GD began intensive discussions with program officials in both countries on ways to bring down costs. American officials discussed the option of reducing the development work on the AIS by switching to a minimally modified standard F-16 AIS or even dropping the AIS development task altogether. Industry representatives also began examining strategies for bringing down wing costs, particularly those associated with the extremely expensive invar metal alloy tooling selected by the Japanese for the cocured composite wing.⁵⁰

After extensive negotiations with MHI, and with costs continuing to mount, GD settled on radical measures to reduce its development costs on the AIS and the wing to keep its total expenditures within TRDI's budget ceiling. In the summer of 1992, the American company agreed essentially to eliminate all development work on the AIS. In its place, the contractors substituted a study of AIS options that could be implemented during the production stage. In the case of the wing, GD finally decided to produce four copies of the left wing only, instead of developing and manufacturing two complete wing sets. This measure would cut the costs approximately in half for the extremely expensive invar tooling needed in Fort Worth for the wing, since tooling for the right wing would not have to be procured. The TSC formally approved these measures in February 1993.⁵¹

U.S. program officials have remained extremely sensitive to the possible implications of such measures—particularly when they relate to the cocured wing—for the politically volatile issues of work-share and work quality. The Pentagon insisted that GD's shift to left wings only must not adversely affect either the scheduled use of U.S.-built wings in ground and flight testing or the overall transfer of wing technology to the American side. After carefully examining the technical details, U.S. officials concluded these changes would not significantly affect the U.S. quality of work or technology transfer. Furthermore, American working-level officials, as well as

⁵⁰Interview with a DSAA official, August 7, 1992.

⁵¹Interview with a DTSA official, June 9, 1993; also see Towle (1992c).

GD managers, remained convinced that U.S. workshare on the program actually stood at above 40 percent of the R&D budget—at least in terms of formal government expenditures—as it had throughout most of the R&D effort.⁵²

In sum, the American side fought hard to prevent the problem of program cost growth from reducing U.S. workshare or adversely affecting the transfer of wing technology to the United States. At the same time, any concerns over the progressive Japanese indigenization of the FS-X that may have existed, except when they related to questions of workshare and technology transfer, were rarely openly expressed. Yet the growth in program costs appears to have been driven in large part by the technological ambitiousness of changes in design and technology to the baseline F-16 sought by the Japanese. Indeed, a second major program controversy that first arose in mid-1991 seemed to confirm the impression left by the cost-growth problem that the FS-X was continuing to evolve further away from the original U.S. conception of a minimally modified F-16.

INDIGENIZATION OF FS-X COMPONENTS AND RELATED TECHNOLOGIES

One other episode in the early stages of the FS-X development program illustrates the Japanese quest for further development of their indigenous military aerospace sector. It concerns the request for a large number of U.S. licenses for fighter components and technologies to permit Japanese industry either to license-produce the components in Japan or to gain access to American technologies for incorporation into Japanese-developed items for the FS-X prototypes. This dispute demonstrated that the Japanese sought to support and increase their own aerospace subcontractors and part suppliers by license-producing standard or modified F-16 parts rather than purchasing them from the United States. Far more interesting, it indirectly revealed that a far larger number of

⁵²Interview with a DTSA official, June 9, 1993. Also see the statement by Vernon Lee, Vice President for Japan Programs, General Dynamics, at the U.S./Japan Economic Agenda's *Conference on High Technology Policy-Making in Japan and the United States: Case Studies of the HDTV and FSX Controversies*, Washington, D.C., June 8, 1993. U.S. officials estimated American workshare at 46 percent in the summer of 1993.

major subsystems and components than the original four major avionics systems were being indigenously developed and procured in Japan.

Perhaps most important, this episode once again illustrates how U.S. policy restrictions on transferring data packages further promoted indigenous development in Japan. As in 1989, American hardliners argued that the Japanese would have to buy U.S. components off the shelf if denied licensed-production rights. And once again, this position ultimately backfired when Japan chose to move toward even greater indigenous development efforts.

Modern fighter aircraft are incredibly complex machines incorporating many hundreds of specialized pieces of equipment, subsystems, components, and parts developed and manufactured by scores of different companies. Such companies are often called "lower tier" vendors, to distinguish them from the prime contractors that design, develop, and integrate the overall aircraft and from other large companies that supply the major aircraft systems, such as jet engines and fire-control radars. While far less visible than the large aerospace prime contractors, these multitudes of often highly specialized and technologically advanced companies are nonetheless critical for maintaining a fully capable national industrial base in the military aerospace sector. Indeed, during the debates in Congress in 1989, opponents often criticized the FS-X deal on the grounds that, while it might provide work and revenue for major contractors, such as GD, Pratt & Whitney, and General Electric, it could hurt smaller suppliers on the lower tiers who were already facing tough competition from Japan.⁵³ As a result of the interagency review of the FS-X MoU in early 1989, U.S. officials recommended that the government seek to minimize modification to the baseline F-16 in part so U.S. second-tier subcontractors could sell standard or slightly modified F-16 items directly to the Japanese for incorporation into the FS-X.

In the summer of 1991, the major Japanese FS-X contractors began in earnest to solicit bids for a wide range of equipment from lower-tier vendors for the FS-X prototypes. In July, Japanese industry released RFPs for around 200 items to more than 100 lower-tier U.S. aerospace suppliers. However, less than half of these RFPs called for direct purchases of finished American products.

⁵³For example, see the testimony of William G. Phillips (Phillips, 1990).

More than 120 represented requests for the export of technology from about 70 U.S. companies to permit either licensed production in Japan or development of modified Japanese items based in part on the U.S. component technologies.⁵⁴

The Debate over Japanese Licensed Production of U.S. Components

American officials disagreed on how to respond to this new Japanese initiative. Much concern was expressed over the possible political repercussions of permitting the transfer of additional U.S. production technology to Japan during the R&D program. Still, the FS-X program agreements did not provide clear and detailed guidance on selecting lower-tier vendors and the transfer of their technologies. Some U.S. Air Force officials at the F-16 SPO leaned toward granting approval for most of the RFPs for licensed production, arguing that Japanese industry had already acquired virtually all the technologies and manufacturing capabilities in question through earlier licensed-production agreements for identical or similar items for the F-15, F-4, and other programs. Furthermore, they pointed out that blocking the requests might spur the Japanese to develop fully indigenous substitutes rather than merely to license-produce or modify the U.S. designs. However, many government officials at DTSA, DSAA, and the DoC opposed the Japanese initiative, arguing that it violated the intent of the MoU and the later clarifications. They insisted that, as in the case of the engine, no license agreements or transfer of production technologies for components should be permitted during the R&D phase, as a means of maintaining U.S. influence over future negotiations over a production MoU.

The American side eventually settled on a compromise approach heavily weighted toward the positions advanced by Pentagon and DoC officials. At the July TSC meeting held at Misawa Air Base in northern Japan, the Japanese presented arguments that licensed production of components or development of new

⁵⁴This account is based on Silverberg (1991) and interviews with a U.S. Air Force program official, June 12, 1992; a U.S. Air Force program official, December 17, 1991, and June 1, 1992; a DTSA official, August 7, 1992, and June 9, 1993; and a DSAA official, August 6, 1992.

items based on U.S. technology was critical for maintaining the prototype flight-test program schedule and ensuring flight safety. They insisted that they needed to have Japanese suppliers in the country working closely with the flight test program to guarantee its success.⁵⁵ The discussions became heated at times over this "safety-of-flight" issue, as some of the Japanese vented their anger and frustration over the general course of the program. Lieutenant General Matsumiya, the Japanese cochair of the TSC, allegedly complained that "Japanese pilots could not fly the FS-X knowing that these parts were made in the U.S."⁵⁶ While most of the American representatives found such assertions unconvincing, they responded that the United States would consider approving a limited list of items on a case-by-case basis, but only if JDA could clearly prove its safety-of-flight arguments for each item. Both sides agreed to convene a special TSC meeting later in the year to resolve the problem after the United States received and reviewed JDA's detailed justifications.

In the fall of 1991, the Japanese submitted a reduced list of 96 items divided into two categories. The Category A list, which represented the highest-priority critical components from the Japanese perspective for licensed-production rights, included 44 items. Category B items were characterized as essential, but not critical, for flight safety. However, the chief justification for licensed-production rights had now shifted to the argument that Japanese companies had to be the suppliers of these items to provide timely modifications and support during the flight test program and to guarantee compatibility with other Japanese-developed components.

Category A included a wide variety of articles, ranging from such relatively mundane items as external drop tanks, actuators, and the landing gear assemblies to more sophisticated components, such as the radar altimeter, HUD, and multifunction display set. In all, about half of the Category A items were related to avionics or the flight-control system.

⁵⁵Japanese military procurement officials have complained for years about the delays and other problems they have allegedly experienced on many programs in maintaining and supporting their aircraft because of their dependence on U.S. contractors located across the Pacific for critical spare parts, repairs, and modifications.

⁵⁶Interview with a DSAA official, August 7, 1992.

More interesting are the modifications and changes the Japanese anticipated to the items on the two lists compared to the equivalent components on GD's standard fighter. The Japanese request for licensed production of these items and the accompanying justifications provide additional insight into how much the FS-X was evolving away from the original American concept of a minimally modified F-16 with maximum use of existing U.S. components. Of the 44 articles in Category A, only two were planned to be identical to existing components already in use on the F-16. JDA plans showed that the overwhelming majority had to be modified prior to licensed production in Japan by the U.S. vendor or by Japanese industry to meet unique FS-X requirements. The remainder would be either different items from various other aircraft or items developed entirely from scratch specifically for the FS-X. Apparently, this general characterization also applied to the 52 items in Category B.

The U.S. Adopts a Hard-Line Position

Yet the dominant concerns on the American side, advanced primarily by DSAA, DTSA, and DoC officials, remained the transfer of U.S. production technology to Japanese industry and the need to retain leverage for the future FS-X production negotiations. As a result of these concerns, U.S. officials granted only limited concessions at a special TSC meeting held in November 1991. The U.S. side rejected the Japanese request on all 52 Category B items. About half the Category A items were approved for licensed production in Japan, but most with significant qualifications. The most common limitation that was imposed restricted the Japanese to an approach designated "build to print," which meant U.S. industry would not transfer design, development, or production data for a given item. Typical licensed-production agreements normally entail the transfer of extensive engineering, tooling, process, and design data. In this case, U.S. companies could only transfer specifications and drawings, supplemented with "form, fit, and function" data to facilitate integration. In addition, the U.S. side restricted many of the approved items even further to what they called "split" licensed production. This required the Japanese to purchase sensitive parts of an item directly from the American vendor and manufacture the rest of it on a build-to-print basis.

The Japanese side expressed considerable displeasure with the U.S. position. MHI had apparently already promised licensed production or modification of many of the items in question to its Japanese vendors. With the American denials and restrictions, MHI now confronted an internal workshare problem with its own component suppliers. JDA and Japanese industry wanted to maintain the industrial base of vendors and suppliers built up through the F-15 program and other licensed-production efforts. Without the right to produce FS-X parts and components, these companies would lose work when F-15 production ended.⁵⁷

On a more profound level, however, the *kokusanka* supporters resented what they perceived as a new and particularly egregious example of the continuing asymmetries between the two sides on access to the other's technology. Furthermore, the Japanese had tried to demonstrate that the Americans had already granted permission to license-produce many of the same or similar items and technologies on earlier programs.⁵⁸ But that was before the congressional debate in 1989. Japanese resentment and frustration with American policy soon found expression in the new approach adopted for the procurement of the components the United States had limited to end-item sales.

The Japanese Response: Even More Indigenous Development

In December 1991, the Japanese held a major program review of the FS-X development effort. It was during this review that program officials formally decided to drop the chin-mounted maneuvering canards because of rising program costs, possible weight problems, and the developmental complexity of the flight-control system. Yet despite the problems with overall R&D cost growth, program officials also rejected direct purchase as end-items from American vendors of virtually all the Category A components recently denied by the U.S. side for licensed production in Japan. Instead, the Japanese approved indigenous development of nearly all

⁵⁷Letter to the author from a U.S. Air Force official, November 1, 1993.

⁵⁸Licenses for the production in Japan of specific items were limited to specific programs. Thus, Japan had to seek a new license to manufacture the same item for the FS-X that it had manufactured for the F-15.

the components in question. Among the handful of items that would not now be developed in Japan, at least two would be procured through favorable licensed-production agreements with non-American foreign vendors.⁵⁹ This decision permitted the Japanese to maintain the manufacturing base of their lower-tier vendors, while enhancing their capabilities to design and develop their own components free from dependency on American firms.

The case of one of these items, the radar altimeter, is particularly instructive.⁶⁰ Prior to November, the Japanese had been discussing licensed production of an advanced digital radar altimeter developed by Teledyne Ryan. The Japanese placed this item on the Category A list, but in November the Americans limited procurement of this device to an end-item sale, assuming the Japanese would be forced to purchase it directly from the U.S. company. In December, however, the Japanese suddenly changed the technical requirement for the system, effectively disqualifying the Teledyne altimeter. The new requirement precisely fit the specifications of a less-capable analog system developed by the French firm, Thomson-CSF. Interestingly, Japan Radio Corporation already had negotiated generous licensed-production agreements with this French company and intended to license-produce the FS-X altimeter. Senior Japanese program officials argued that the French system was superior in cost, performance, and weight to the American candidate. Most American officials did not find these arguments compelling. Some believed the Japanese intended to send the message that, if the U.S. side continued to restrict licensed production and access to American component technology, the Japanese had viable alternatives to end-item purchases from U.S. companies.⁶¹

⁵⁹Several American officials, particularly at DSAA, argued that procurement of components from third countries violates the intent of the MoU and associated agreements. The Japanese rejected this position, and this issue was never clearly resolved.

⁶⁰This account is based on interviews with a DSAA official, August 7, 1992; a U.S. Air Force official, June 12, 1992; and a Japanese TRDI official.

⁶¹Other American officials dispute the accuracy of this account. They claim that the Japanese did not change the requirement at the last minute, because no final decision had yet been made. When that decision was made, they claim, Teledyne first argued against it, then provided a technically inadequate proposal. The Japanese therefore chose the better technical solution provided by Thomson-

Like the dispute over program cost growth and schedule slippage, the whole episode about licensed production of components reflects the profound changes the FS-X had been undergoing since the U.S. imposition of collaboration based on the F-16 at the end of 1987. It shows that, in addition to the extensive airframe modifications and the indigenous development of the four major avionics subsystems, significant numbers of critical components—ranging from landing gears to actuators to sophisticated avionics items, sensors, and instruments—would all have to be modified or newly developed for the FS-X. In addition, it highlighted the unyielding determination of the *kokusanka* supporters to maximize indigenous development and domestic manufacture of component technologies, even in the face of severe budgetary pressures that should have made cheaper U.S. off-the-shelf or modified components more attractive. This episode seems to confirm the view that maintenance and further development of a national military aerospace industrial base remained a primary objective of the program.

Indeed, by mid-1992, U.S. program officials calculated that the Japanese were essentially indigenously developing nearly 40 important new FS-X subsystems in addition to the four major avionics systems.⁶² The U.S. side estimated that the Japanese would eventually seek to work with between 100 and 200 lower-tier American companies to help develop modified or all-new subsystems and components. Ironically, the *kokusanka* objective of maximum indigenization had actually been indirectly promoted by the U.S. determination to control technology transfer and the refusal to grant permission for licensed production of U.S. components. Yet, as the FS-X continued to evolve toward something approximating an all-new national fighter, U.S. attention remained fixed on the contentious economic issues of technology transfer, U.S. workshare, and access to Japanese technology.

With increasing American recognition of the high Japanese technology content in FS-X, new battles began to loom on the horizon as the question of access to indigenous Japanese technology moved increasingly toward center stage. It is not surprising that this question, rather than the progressive Japanese indigenization

CSF, as they claimed. Letter to the author from a U.S. Air Force official, November 1, 1993.

⁶²Interview with a U.S. Air Force official, June 12, 1992.

of the FS-X, dominated much of the attention of the U.S. side during the early phases of the R&D program. Yet, even here, the Americans were able to achieve only moderate success at best, and the problems the U.S. side encountered were hardly caused exclusively by the Japanese.

**THE FIRST THREE YEARS OF R&D:
GAINING ACCESS TO JAPANESE
FS-X TECHNOLOGIES**

INTRODUCTION

After the 1989 debate in Congress, both U.S. and Japanese program officials clearly understood the great political importance and sensitivity of the question of U.S. access to FS-X technology. To demonstrate genuine technology reciprocity and counter the allegations of a U.S. technology giveaway, the U.S. side felt compelled to press hard for access to Japanese technology and for the free and expeditious flowback of derived technology. No area was more sensitive than Mitsubishi's cocured composite wing, which had caused so many problems over U.S. access rights during the original program negotiations.

Unfortunately, the ever-widening divergence between the original conception of the program as a modestly changed F-16 and the reality of a radically modified fighter incorporating extensive Japanese design alterations and new technology applications posed mounting problems for negotiators on both sides. The original agreements formally designated only the four main Japanese avionics systems as nonderived technology. All other aspects of the aircraft were defined as derived technology, which obligated Japanese industry to transfer that technology to the United States expeditiously and without cost. Not surprisingly, Japanese companies did not want to give away technology they had developed themselves, often as the result of a U.S. refusal to permit the

transfer of data packages on U.S.-developed items. The American side, however, felt obligated to stick to the deal's original terms.

The problem of derived versus nonderived technology became increasingly serious as the R&D program progressed. Nonetheless, for the first several years of the development effort, U.S. officials focused most of their attention on the high-visibility Japanese technologies that had been touted by the administration and supporters of the deal during the 1989 debates: the composite wing and the four officially nonderived avionics systems.

This chapter focuses on these issues during the R&D program.

TRANSFERRING THE WING TECHNOLOGY

As recounted in previous chapters, the question of free and expeditious U.S. access to MHI's technology for large cocured composite structures and GD participation in developing and manufacturing the FS-X main wing emerged as one of the principal disputes causing friction and delays during the MoU negotiations throughout 1988 and follow-on negotiations the next year. Ultimately, the two sides had signed a special side agreement guaranteeing U.S. access through GD participation in the design, development, and manufacture of two of the six prototype wing sets, but many Japanese did not believe the problem had been genuinely settled. During the 1989 congressional debate over the FS-X deal, access to the wing technology rose to even greater prominence as administration officials touted U.S. involvement in the wing development as one of the key benefits of the program.

But MHI had never been happy with the American insistence on free and expeditious transfer of the wing technology, and the MoU clarification process only increased Japanese resentment. In the latter half of 1989, the battle over the wing once again flared up when MHI demanded that GD pay a fee for using the wing technology on other programs, and MITI insisted on restrictions on transferring the technology to third parties. The increased importance and political prominence of free and expeditious U.S. access to the wing technology following the public FS-X controversy prevented the American side from compromising. Once again, the United States had to apply heavy political pressure on the Japanese to reach a resolution. With Mitsubishi refusing to budge from its position, JDA had finally agreed to pay the Japanese con-

tractor the fees it sought, allowing the Americans to use the technology free of charge. In February 1990, the Japanese also essentially relented on most of the restrictions about transferring the technology to third parties.

Nonetheless, MHI had won a major victory in the agreements signed that same month with the reconfirmation of its "leader-follower" relationship with GD. With the continued delays in the actual start-up of the cooperative R&D effort caused by the need to work out details of specific work tasks, the slow transfer of the F-16 TDPs, and the emerging controversy over GD's increased cost estimates, Mitsubishi proceeded with designing and developing the wing largely independent of any significant U.S. contractor influence. The U.S. side did not object, in part because the interagency agreement on technology transfer negotiated by the DoC and DoD in early 1989 had recommended increased restrictions on GD participation in designing the wing to prevent the transfer of American design methodologies and techniques to Japanese companies. The net effect of this situation was that GD played little direct role in designing and developing the wing or other aspects of the airframe (except for the aft fuselage and leading-edge flaps, which are its lead tasks).¹

Nonetheless, working-level officials on both sides clearly recognized that transfer of the wing technology stood out as the most important political symbol for Congress of the U.S. demand for greater technology reciprocity from Japan and would serve as a lightning rod for criticism if it was not fully implemented. To ensure full transfer of the technology, the FS-X agreements called for GD to manufacture its two wing sets in Fort Worth using materials, processes, and tooling identical to those used by MHI in Nagoya. Furthermore, GD's wings had to pass the same rigorous tests and meet the same standards as the Japanese wings. As a final guarantee, the agreements required the Japanese to use one set of the American-manufactured wings on the flying prototypes during the flight test program and one set for static ground tests.

Yet program officials were navigating uncharted waters. No obvious mechanism existed for easily transferring the technology to

¹Interviews with U.S. industry officials and engineers, June 15, 1992. However, several GD engineers did participate at MHI Nagoya during the conceptual and preliminary design phases of the wing (Lockheed Fort Worth, letter to the author, March 11, 1994).

GD, particularly since MHI was still essentially developing the wing. As a result, the technology and processes associated with the wing remained in an immature and preliminary stage. Furthermore, GD and the three Japanese contractors planned to conduct much of the R&D independently for their assigned lead tasks at their own facilities on opposite sides of the Pacific. While the four primary firms had also agreed to set up a joint engineering group at a special facility at Mitsubishi's main plant in Nagoya, this group would not focus on the transfer of the wing technology to the United States. This joint group, known as the Fighter Support Engineering Team (FSET), would be primarily responsible for the overall detailed design of the fighter and would facilitate transfer of the F-16 TDPs to Japan and derived Japanese technology back to the United States. The FSET was anticipated to build up in 1991 to about 70 to 80 GD engineers and around 200 to 250 engineers representing the three major Japanese contractors. GD also planned to maintain a small office in Nagoya.²

A Poor Start: The Initial Coupon-Test Failure

Unfortunately, in the early phases of the actual development effort, communications between the American and Japanese contractors remained poor. GD engineers at the FSET continued to play a relatively minor role in designing and developing the wing. GD had only two engineers specializing in wing design and manufacturing on the FSET, and the Japanese did not extensively use them. The typical GD engineer at the FSET worked on relatively minor items, such as metal fittings for the leading-edge flaps, not major design questions. Japanese industry made all the key engineering and integration decisions. While these decisions were usually transmitted to the Americans, the rationale and design philosophy behind them often were not. As shown in Figure 11.1, the majority of GD engineers at the FSET in mid-1992 were assigned to the structural and avionics subgroups because of GD's lead tasks on the aft fuselage and several specific avionics systems, such as the SMS. The American engineers were engaged very little in work outside the lead tasks assigned to the American company.

²GAO (1992a), p. 14. Also see "Joint FS-X Team at Work" (1991); and Towle (1992c).

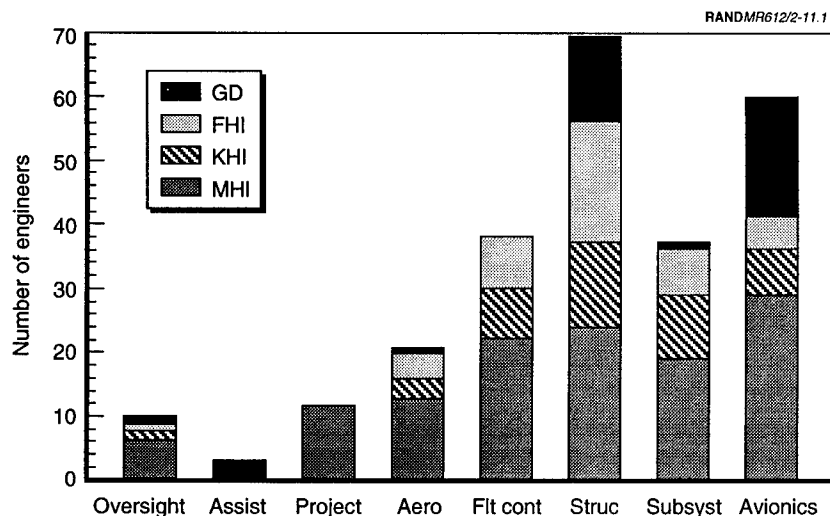


Figure 11.1—FSET by Engineering Subgroups, April 1991

Lingering resentments and distrust between the two sides, as well as cultural barriers, also made genuine cooperation difficult. Few GD engineers spoke Japanese. The Americans' high hourly rates limited them to a standard 9-to-5 work day, while the Japanese engineers often worked and socialized together late into the night. Except for the aft fuselage and leading-edge flaps, for which GD had the design lead, the Americans often felt they were being treated like consultants whose main task was simply to answer questions on the F-16 TDP to help the Japanese engineers carry out their own national modification and development effort.³

Given this initially poor working relationship, it is not surprising that the transfer of the wing technology got off to a rocky start. MHI did fulfill its obligations for transferring much of the wing documentation and data, but a strong working relationship between the two companies necessary to begin implementing the actual manufacturing process at Fort Worth did not yet exist. From April to September 1990, MHI translated and transferred background test data to GD mainly relating to the prototype wing test

³Interviews, Glen Levis, GAO Audit Office, Pentagon, April 9, 1991; a DSAA official, April 9 and May 2, 1991; and U.S. Air Force officials, June 10-11, 1991.

article seen by the Sullivan team back in 1987. JDA transferred additional government-owned data to the American company through the U.S. Air Force FS-X office at the F-16 SPO. In February 1991, Mitsubishi began transferring the design and process data necessary for GD to develop the production tooling and make test specimens in preparation for the actual manufacture of the wing sets to be used on the FS-X prototypes (GAO, 1992a, p. 21).

However, when GD began its actual manufacturing preparations, problems arose. One of the first stages of the effort involved manufacturing a small sample composite piece—a “coupon”—at the Fort Worth facility using MHI’s material system, specifications, and process technology. When GD engineers tested the completed composite article early in 1991, they discovered it fell short of specifications and standards established by MHI. Initially, this coupon-test failure caused great concern among U.S. and Japanese program officials. U.S. officials feared that the apparent inability to transfer this relatively simple first step did not bode well for transfer of the far more complex and difficult tasks of tooling up and manufacturing the entire wing box.

Steady Improvement: The Integral Tank Test

These concerns soon began to diminish as both sides worked to improve communication between the U.S. and Japanese firms. After the coupon-test failure, the U.S. government side learned that GD had sent only a single engineer for about a week over to Nagoya to observe the MHI process. This engineer had only taken handwritten notes, and MHI had not provided formal written documentation for the coupon test. GD had later developed its own test plan for the composite test article and sent it to MHI as required, but GD had not waited for an approval from the Japanese contractor. After the coupon-test problem emerged, TRDI took strong action with MHI about the importance of managing the transfer of wing technology. MHI sent a team to Fort Worth during the summer to provide more detailed data and supervision on site. After these more extensive interactions, the American contractor conducted the coupon tests again. This time, the GD-made composite test articles met all specifications.

The next phases in the transfer process, which entailed tasks that were considerably more demanding, progressed more smoothly

as the relationship between GD and the Japanese firms improved. These phases included manufacturing an "integral test tank" specimen and a substructure test article. The first item simulates the integral wing fuel tank, a major structure roughly 3 by 13 ft, representing about one-quarter the size of the full wing box. It includes the cocured spars, ribs, and lower wing skin of the production wing. The second item tests the internal structural design at the wing root, a critical area of high aerodynamic stresses on the actual aircraft. The purpose of both test articles is to verify the tooling, design, materials, and manufacturing processes that will later be applied to the entire cocured wing box. For the integral test tank, engineers first produced a dummy part made of fiberglass. Then, a CFC test article was manufactured to verify the tooling and to refine the manufacturing process. Finally, a full-scale engineering test article was made. The prototype articles were then subjected to a variety of tests.⁴

Transferring the manufacturing process for these test articles was not simple. First, the Japanese used two completely separate CFC material systems on the wing. Fuji developed the upper wing skin based on a material system from Toray Corporation of Japan. Japanese engineers planned to attach the Fuji upper wing skin using mechanical fasteners to the cocured lower wing structure developed by Mitsubishi. The latter structure was based on a different material system from Mitsubishi Rayon Corporation (MRC). MHI had tailored its materials and tooling to the unique needs of its cocuring process for manufacturing the wing. This process entailed the use of very expensive tooling manufactured from invar steel, an alloy that is quite difficult to form and machine. The Japanese manufacturing approach also required using inflatable silicon bags, with which GD had little experience.⁵

Thus, GD had to work with two new material systems and a manufacturing process with which it was not familiar. To avoid the type of problems experienced earlier on the initial coupon test, technicians videotaped every step of the manufacturing process at MHI for laying up the composite materials on the Japanese-developed invar tooling. In addition, GD engineers

⁴Interviews with U.S. industry officials and engineers (1992). Also see "FS-X Parts Fabricated" (1992).

⁵Interviews with U.S. industry engineers, August 4, 1992.

visited MHI to learn more details of the process in person. Finally, a Japanese team of engineers visited the United States to assist in manufacturing the highly specialized invar tooling in the United States, which GD subcontracted to lower-tier vendors.⁶

As a result of this improved communication and greater interaction, this more complex phase of the transfer of the wing manufacturing process apparently went surprisingly well. The American-made invar tools met all specifications and quality standards established by the Japanese. By late 1992, GD had successfully manufactured two integral wing-tank test articles, which generally met the same specifications as similar items built in Japan. The U.S. company also manufactured the upper wing skin that would be mechanically fastened to the rest of the structure, as well as additional composite wings spars for testing and design verification.⁷ GD officials enthusiastically touted these achievements as a clear demonstration that the Japanese cured composite technology was being successfully transferred to the United States. As the GD project team leader told reporters at the time, "we are duplicating exactly Japanese materials and processes."⁸

GAO Confirms Transfer of the Wing Data

GAO's 1992 midyear audit of the program for Congress seemed to confirm the growing public enthusiasm of the GD officials. It noted that the American company had received "drawings, material lists, process and test specifications, and photographs of production tools" for the wing. It concluded that the "composite wing technology is being transferred to GD." (GAO, 1992a, p. 21.) By mid-1993, the transfer of the wing technology stood out in the opinion of many U.S. officials as one of the great successes of the FS-X program. At that time, Dr. Vernon Lee, Vice President for Japan Programs at the Lockheed Fort Worth Division,⁹ publicly stated that "technology transfer from Japan to the United States is hap-

⁶Interviews with U.S. industry engineers, August 4, 1992.

⁷"General Dynamics Corp." (1992).

⁸James Shidler, quoted in Towle (1992c).

⁹In December 1992, General Dynamics agreed to sell its Fort Worth fighter division to Lockheed Corporation for \$1.525 billion. The deal was finalized on March 1, 1993. See Mintz (1993).

pening on a massive scale,” and that the wing technology had already been “completely transferred.”¹⁰ Figure 11.2 shows the transfer of data items on the wing and other aspects of FS-X from MHI to GD from January 1991 to July 1992, by which time nearly 3,000 data items had been transferred. Two years later, the number had skyrocketed to over 16,000 data items.

While the American company expressed complete satisfaction with the Japanese transfer of wing technology, at least one major shortcoming appears to have been present. Since GD engineers took only a relatively small part in the design and development of the wing, its tooling, or its manufacturing process, the American company’s task of manufacturing the wing in some respects more closely approximated a licensed-production program than a cooperative development effort. In this sense, the Japanese transfer of the wing technology to GD mirrored the limitations imposed by the U.S. government on the transfer of F-16 data to Japan.

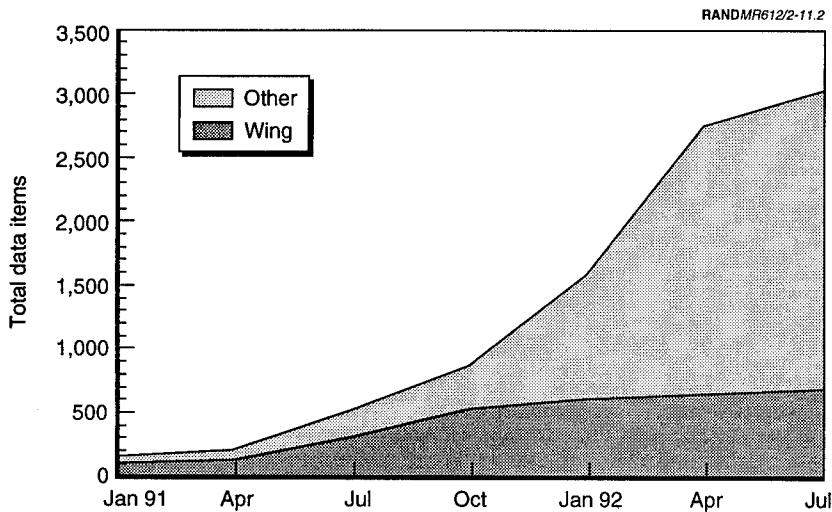


Figure 11.2—Wing and Other Data Items Transferred from MHI to GD Through July 1992

¹⁰Statement at the U.S./Japan Economic Agenda’s conference, June 8, 1993.

In a licensed-production program, only process data and drawings are normally transferred. In addition to such information, GD also received engineering packages from MHI on the FS-X program, which included such design test data as wind-tunnel test results. The MHI-GD leader-follower relationship permitted U.S. engineers to observe and duplicate much of the development process for the engineering, tooling, and manufacturing approaches. Nonetheless, GD did not participate as an equal partner in the original development process in Japan.¹¹ While the data packages provided by the Japanese go considerably beyond what is transferred in a typical licensed-production program, they nonetheless only show the successful design and development path chosen by the actual developer. These data do not necessarily reveal the reasons or rationale behind critical design and development decisions. This is precisely why U.S. government officials insisted in 1989 on denying Japanese access to design and engineering data on earlier versions of the F-16: to prevent Japanese engineers from discerning the developmental process through which the Americans arrived at the final Block 40 F-16 design and configuration. Thus, through at least the end of 1992, most GD engineers believed they would probably learn the know-how for manufacturing the wing but probably not the know-why behind its design and manufacturing processes.¹²

This situation may have improved somewhat in 1993. With strong U.S. government encouragement, GD launched a new effort in late 1992 to gain more insight into the design and manufacturing philosophies underlying the MHI wing approach. More will be said on this question in Chapter Twelve. Nonetheless, it seemed evident by the end of 1992 that MHI was fulfilling the basic requirements of the program agreements and transferring a considerable amount of data to the American side. Whether or not those data would prove useful, or even that U.S. industry would seriously assess them, remained uncertain.

¹¹In large part because of restrictions imposed by the U.S. government after the "clarifications" crisis in 1989.

¹²Interviews with U.S. industry officials and engineers, August 4, 1992.

ACCESS TO THE FOUR JAPANESE AVIONICS SYSTEMS

For the purpose of U.S. access rights, the original FS-X agreements and the 1989 clarifications had designated the four major Japanese-developed avionics systems—the APA fire-control radar, the IRS, the mission computer (MC), and the IEWS—as the only nonderived or fully indigenous Japanese technologies to be incorporated into the fighter. The Japanese government had explicitly agreed not to block the transfer of nonderived technologies to the United States in the implementation agreement signed in February 1990 by granting what amounted to blanket JMTC approval for such transfers. However, as envisioned by U.S. officials, the actual transfer of nonderived technologies would have to be negotiated by interested American companies dealing directly with the relevant Japanese firms and would entail payment of a mutually agreed-upon fee for the right to acquire the technology. The U.S. government hoped to play the role of facilitator by helping to identify specific Japanese technologies of interest to DoD, informing U.S. industry, and encouraging American companies to enter into agreements with Japanese firms. The American government would also step in if it perceived any unwillingness by the Japanese government to permit Japanese firms to transfer a specific technology of interest to a U.S. company.

Initially, some U.S. government officials expressed lingering doubts about the potential effectiveness of the agreements for transferring nonderived technology. While the agreements guaranteed the Japanese government would not block transfer, they did not ensure that U.S. firms could gain access to technologies of interest. For example, nothing prevented Japanese companies from refusing to negotiate or demanding prohibitive fees for the transfer. On a more profound level, American officials began questioning what precisely constitutes technology transfer. Does it mean transferring all the basic design and engineering data that provides the know-how and the know-why, or does the sale of parts or components as end-items meet the requirements? Finally, the U.S. side had to wrestle with developing mechanisms both for identifying specific technologies of interest to DoD and for disseminating

the information to U.S. industry and encouraging it to open negotiations with Japanese firms.¹³

Focus on the MELCO APA Radar

Nonetheless, everyone on the working level recognized the critical political importance of moving ahead rapidly on gaining access to nonderived technology, particularly MELCO's APA radar. During their testimony before Congress in 1989, senior administration officials had repeatedly emphasized the great potential value to the U.S. defense industry and DoD of learning MELCO's techniques for manufacturing lower-cost T/R modules used in its APA radar antenna array. American access to the radar, along with MHI's composite wing, had been sold to a skeptical and hostile Congress as primary benefits of the program, more than compensating for the transfer of F-16 technology to the Japanese. The CRS study presented to Congress at the height of the FS-X debate, which many observers credited with helping save the FS-X deal in the Senate, had specifically targeted U.S. "access to basic design, performance and cost data" on the radar as one of the greatest potential benefits of the program (Moteff, 1989, p. 10; see also Chapter Nine). U.S. officials understood that failure to show quick progress on the access agreements could renew the controversy in Congress.

Furthermore, following the interagency review in the spring of 1989, DoC officials became committed to gaining U.S. access to the radar and other nonderived technology. DoC took the position that it would vigorously pursue such access, regardless of the level of interest expressed by either the Pentagon or the Air Force. This was viewed as part of a much broader effort the DoC and other government agencies were pushing to win greater technology reciprocity from Japan through a revitalized S&TF and JMTC.¹⁴

DoD and the service laboratories, of course, were also interested in learning what they could from the Japanese and did not need any special encouragement from the DoC to seek access to the MELCO radar. As mentioned earlier, Pentagon officials were very concerned about the high cost of T/R module fabrication for the

¹³Interviews with U.S. Air Force R&D and FS-X program officials, June 10, 1991.

¹⁴Interviews with DoC officials, April 11, 1991.

ATF (the F-22) and other U.S. programs and were eager to learn if Japanese manufacturing techniques could be used to reduce production costs in the United States.¹⁵

Not surprisingly, then, once the R&D program got under way, American officials immediately began pressuring the Japanese for more detailed information on the MELCO radar to assist the U.S. side in assessing the specific technology areas of greatest potential interest. At the very first official TSC meeting held in August 1989, U.S. representatives requested approval for about ten government technical experts to visit Japan for detailed JDA briefings on the APA radar and to visit the companies involved in its development. The Americans proposed that such a visit take place before the end of the year. Although the trip took longer to arrange than the Americans would have preferred, the Japanese eventually agreed to an 11-day visit to take place in late March and early April 1990 (GAO, 1992a, p. 21).

U.S. Radar Specialists Visit Japan

The U.S. side assembled a team of 13 Air Force and Navy radar specialists and engineers representing various military research facilities. The team visited TRDI and several MELCO plants involved in the APA radar program. It came away from the visit extremely impressed with the Japanese-developed antenna array and its component T/R modules, as well as with MELCO's advanced design and manufacturing capabilities. A month prior to the team visit, GAO had published a report confirming its generally negative initial findings on Japanese indigenous FS-X technologies, which had been briefed to Congress at the height of the 1989 debate over the program. This report concluded that "the Japanese radar and associated manufacturing processes are of questionable value to the United States in the near term." (GAO, 1990a, p. 30.) After its trip to Japan, the U.S. technical team strongly disputed this conclusion, arguing that the GAO findings had been based on old and incomplete information. Indeed, the team's principal conclusion, as recounted in a later GAO report, was that "Japan's technology [is] far more competitive with similar U.S. radar technology than was previously believed." (GAO, 1992a, p. 22.)

¹⁵Letter to the author from U.S. Air Force officials, November 1, 1993.

Although the American team members had been quite impressed with what they saw on the first radar visit, they nonetheless had only learned about the general characteristics of the prototype engineering model of the APA radar. With their appetites whetted for more Japanese data, the U.S. specialists soon requested a follow-on visit. The Americans hoped to acquire much more detailed information on the design, performance, and manufacturing techniques for the radar and its components, particularly the T/R modules. Detailed technical questions were submitted to the Japanese in preparation for a second visit. Eventually, officials scheduled a new trip for May 1991. Although this time the Japanese permitted the U.S. engineers to view the facility that actually fabricated the GaAs MMIC chips for the FS-X radar T/R modules, the GAO later noted that "Japanese officials declined to answer many technical questions about radar test data." (GAO, 1992a, p. 22.)

U.S. Concerns Over Technology Transfer

Many U.S. participants returned from the second visit somewhat discouraged. They believed the Japanese were not providing sufficient data to permit a thorough U.S. assessment of the performance, cost, and manufacturing technologies for the radar and its components. This was a matter of interpretation, however, since the FS-X agreements did not specify precisely what data on what level of detail the Japanese had to provide to permit the U.S. side to assess reasonably whether to pursue transfer of a specific technology further. MELCO considered many important data the Americans requested to be proprietary information that it was not obligated to hand over. TRDI and MITI appeared to be blocking some requested data on the grounds that they were classified or that similar data had not been provided to the Japanese on the F-15 program.¹⁶

Even more discouraging, many American experts began to realize that a whole series of thorny issues and problems that had not been anticipated by the framers of the original FS-X agreements could make meaningful U.S. utilization of Japanese radar technology extremely difficult. The principal areas of DoD interest

¹⁶Interviews with U.S. Air Force program officials, June 10, 1991.

had always been publicly identified as Japanese production techniques for reducing the costs of manufacturing T/R modules and their associated GaAs MMIC chips. Unfortunately, the U.S. team had been unable to acquire definitive data on Japanese T/R module costs and production technology. Even worse, the approach that MELCO adopted for manufacturing the T/R modules for use in the FS-X R&D program raised serious questions about its relevance to American interests and whether the United States actually had access rights to MELCO's automated dual-use manufacturing technology under the terms of the FS-X accords. Finally, on a broader level, there was the question of whether MELCO's manufacturing processes—based on a dual-use philosophy of simultaneously utilizing techniques and even the same machines developed in the commercial sector to both civil and defense applications—could ever be transferred to an American defense industry that was structured in a way that inhibited crossover between the commercial and defense arenas.

During the radar visits, the Americans observed that “the design and manufacturing process Japan used to produce radar modules appeared to be very similar to that used by U.S. industry.” (GAO, 1992a, p. 22.) Indeed, many of the machines the company used were American-made. The U.S. team learned that MELCO had already completed assembly of the relatively small number of T/R modules for installation on the handful of engineering model radars that would be used during the FS-X prototype test program. Since the production run was so small, MELCO technicians had manually assembled the modules at a relatively high unit cost instead of employing the sophisticated automated assembly methods the company generally used on other related high-volume commercial applications. Although this cost apparently remained well below that of the U.S. T/R modules used for the APA radar during the demonstration and validation prototype phase of the U.S. Air Force's ATF program, it was still considerably above the production goal of \$400 to 500 per module U.S. industry had established. Furthermore, the prototype T/R modules Westinghouse and Texas Instruments developed for the ATF appeared to possess much higher performance capabilities than MELCO's modules. MELCO officials told U.S. team members that they expected their module unit costs to drop below \$1,000 during FS-X production because of the much larger production volume, assuming procurement of 130 aircraft.

At the same time, they implied that they would not employ their fully automated high-volume, low-cost production methods unless daily production demand rose to levels five to ten times higher than that anticipated during FS-X production.¹⁷

This information raised several disturbing issues. First, assessment of the potential value of Japanese technology for bringing down U.S. module costs required far more detailed data on the performance of MELCO's T/R modules and on the company's dual-use automated manufacturing techniques, as well as on production costs. However, the Japanese did not seem inclined to provide this type of information. Second, since MELCO had apparently decided not to use full automation when manufacturing the FS-X T/R modules, even during the production phase, it was far from certain whether the U.S. side could actually exercise formal access rights to MELCO's dual-use automated manufacturing methods under the FS-X accords. Finally, U.S. team members gained the impression that MELCO officials held a profoundly different view than the American side did of what constituted technology transfer. The Japanese implied that the only way to significantly reduce their module costs was to increase production well beyond what the FS-X program required. This raised suspicions that the Japanese firm was actually making a sales pitch, seeking consideration as an off-shore supplier of low-cost, high-quality T/R modules to be sold directly as end-items to major U.S. radar system integrators, such as Westinghouse. Many on the American side, of course, sought to transfer manufacturing process technology and know-how to American firms, not import end-items from Japanese vendors. Nonetheless, the suspected Japanese interpretation of technology transfer was not necessarily inconsistent with the wording of the FS-X agreements.¹⁸

Perhaps most troubling, some U.S. technical experts came to view the Japanese advantage in low-cost module production—if indeed it really existed—as arising more from differences in industry organization and structure, management philosophy, and procurement regulations than from some identifiable and exclusive

¹⁷GAO (1992a), p. 22, fn. 1, and interview with a U.S. Air Force R&D laboratory official, December 19, 1991.

¹⁸GAO (1992a), p. 22, fn. 1, and interview with a U.S. Air Force R&D laboratory official, December 19, 1991.

Japanese manufacturing technology. After all, MELCO seemed to be using the same American-made equipment and design and manufacturing processes as U.S. industry. Some U.S. observers believed that MELCO had a cost advantage because of the unique Japanese industry structure of supplier networks and the special relationships between vendors and prime contractors, as well as because of the Japanese ability to take advantage of commercial spin-on through the structural integration of commercial and military production. If this view proved correct, observers wondered how an entirely different R&D philosophy and industry structure, rather than a specific technology, could possibly be transferred from Japan to the United States.¹⁹

Efforts to Interest U.S. Industry in MELCO Radar Technology

Confronted with these concerns about the feasibility of transferring production technology, U.S. program officials decided to focus on the role of facilitating greater contacts between American and Japanese electronics firms in the hopes that beneficial relationships could eventually be worked out on an industry-to-industry basis. Increasingly, the U.S. government side viewed its principal tasks as searching out more information on Japanese avionics systems and their associated technologies and disseminating this information—along with an explanation of U.S. access rights under the FS-X accords—to a wide spectrum of American electronics firms. Any actual transfer of technology would be left to the American and Japanese firms to work out on a commercial basis.²⁰ DoD and the Air Force took the lead on the first task, while DoC accepted overall responsibility for coordinating U.S. industry access to nonderived technology.²¹ Although these tasks appeared relatively straightforward and uncomplicated, they

¹⁹Interviews with U.S. Air Force officials, June 10, 1991. An extensive assessment of the development of the MELCO APA radar and the Japanese R&D strategy of “spinning on” technology from the commercial sector can be found in Chang (1994). Chang includes a detailed discussion of the structural differences between U.S. and Japanese industry which would make American adoption of the Japanese approach difficult.

²⁰“FSX Not Keeping Its Promise as Technology Cornucopia for U.S.” (1992).

²¹Interview with a DoC official, July 29, 1993.

proved challenging indeed. Before the tasks could be carried out, many on the U.S. side argued that U.S. access rights, as well as definitions of such basic terms as "technology transfer" as they applied to both the nonderived and derived categories, had to be more clearly spelled out and formalized.

The original FS-X MoU had called for the preparation of an Implementing Arrangement (IA)—not to be confused with the MOIA about broad principles of technology transfer signed in February 1990—that would lay out organizational details of program conduct. The IA had been approved at the end of 1989. It established several committees to develop more detailed procedures for specific program details and to codify these procedures in annexes to the IA. One of these committees was tasked with writing the Technology Transfer Procedures (TTP) annex. Due in part to the frequent controversy and many disputes surrounding technology transfer, work on the TTP progressed slowly.

Both sides approved the initial version of the TTP in February 1991. However, at that time, program officials realized that the document would have to be expanded and updated to implement fully the objectives of technology transfer as the program evolved. After the second radar visit, U.S. officials decided that the wording of the TTP had to be tightened up considerably to include, among other things, a more detailed and comprehensive definition of technology transfer and related terms to increase U.S. prospects for access to Japanese data. In the summer, an internal dispute broke out on the U.S. side when Pentagon and Air Force personnel criticized the DoC for not coordinating its efforts in this area more closely with other government agencies (Adams, 1991). As a result, program officials formed the Interagency Working Group on Technology Transfer to facilitate completion of a revised and more comprehensive TTP, which was soon worked out. In the fall, discussions continued with the Japanese over the final wording of the document.²²

While these discussions dragged on, the U.S. side continued trying to get more data on the radar from the Japanese so that government technical experts could identify and assess the specific technologies and processes of greatest potential interest. American program officials fully recognized that the failure to acquire more

²²Interviews with U.S. Air Force officials, June 10, 1991.

extensive data on the radar carried with it potential domestic political repercussions as serious as those the initial problems about access to the wing technology had posed. At the same time, DoC officials in particular worked on the problem of educating U.S. contractors about Japanese technology developments and American access rights under the FS-X accords. During the controversy JDA's request for the licensed production of U.S. parts and components caused in the summer of 1991 (see Chapter Nine), it had become clear that American subcontractors and lower-tier vendors possessed little knowledge of the technology transfer and access provisions of the FS-X accords. This revelation could hardly have surprised U.S. officials, however, since all of the FS-X agreements are classified or subject to restricted access at the request of the Japanese government. Furthermore, the American personnel participating on the radar visits in 1990 and 1991 were limited to U.S. government officials. Although American technical experts wrote extensive trip reports based on these visits, these documents contained MELCO proprietary data in the Japanese view. Therefore, the Japanese government would not permit the dissemination of the trip reports outside official U.S. government circles.

The U.S. side began exploring a variety of ways to overcome these barriers. Initially, officials focused on developing brief "sanitized" trip reports and other documents, purged of all proprietary data and other information sensitive to Japan, which could be distributed to industry to explain U.S. access rights and the technical findings of the government radar visits. Such documents, however, had to be approved by JDA, and that process proved to be slow and sometimes frustrating. At the end of September 1991, an interagency team led by Joan McEntee, Deputy Under Secretary of Commerce, and Carl Ford, Principal Deputy Under Secretary of Defense, visited Japanese government and industry officials to discuss technology transfer and other issues. During meetings with MELCO officials, the U.S. side raised the subject of holding a symposium in the United States for American industry representatives on the FS-X radar with some information included on other non-derived avionics systems. The purpose would be to educate interested American companies about Japanese technology developments, as well as Japanese government export policy and U.S. access rights under the FS-X accords. MELCO officials appeared to react favorably to the suggestion. However, JDA approval for

such a symposium would be needed, and the American side knew such approval would not come quickly.²³

Meanwhile, after considerable U.S. effort, the Japanese finally agreed to provide the U.S. government with some additional data on the radar and T/R modules. American program officials may have been indirectly aided in this effort by a major Bush administration diplomatic offensive launched in the fall of 1991 designed in part to apply greater pressure on Japan in the area of defense burden-sharing. Officials planned to cap the effort with a presidential visit to Tokyo in January 1992 for meetings with Prime Minister Kiichi Miyazawa. During the January meetings in Tokyo, senior defense officials intended to discuss specific technology areas for direct U.S.-Japan cooperation and promote the greater two-way transfer of military technology. In early November, Secretary of State James Baker and Carla Hills, the USTR, went to Japan to discuss regional security issues and trade frictions in preparation for the visit by President Bush. The same month, Secretary of Defense Cheney gave an important address calling on Japan to go beyond financial burden-sharing by increasing U.S. access to Japanese defense-related technology, particularly electronics (see Goozner, 1991; Usui, 1992a). Against this backdrop of high-level administration pressure on improving defense technology cooperation, JDA finally provided "a limited amount of test data" in November on MELCO's APA radar to the U.S. side and spelled out in greater detail what technical questions it would and would not answer about the radar (GAO, 1992a, p. 22).

Negotiating to Purchase T/R Modules for Testing in the United States

Still unsure whether Japan would ever provide all the data U.S. officials believed they needed to adequately assess MELCO's radar technology, the American side had also begun exploring the possibility of purchasing or leasing some T/R modules from the Japanese company for testing in the United States at a government laboratory. In initial discussions, MELCO appeared willing to work out a sale of T/R modules, but JDA and MITI apparently raised objections. Japanese officials ruled that the modules repre-

²³Interview with a DoC official, July 29, 1993.

sented military rather than dual-use technology. It will be remembered that, in the 1983 Exchange of Notes and the 1985 Detailed Arrangements for military technology transfer, Japan had exempted the United States from its prohibition against the export of military technology. These agreements also confirmed the declaratory Japanese government policy of placing no restrictions on the export of dual-use technology to the United States. However, MITI, with the general support of JDA, pointed out that these agreements only permitted the transfer of military *technology*, not military *hardware*. In its view, the T/R modules were military hardware and thus could not be exported even to the United States.²⁴

Many American program officials found the Japanese government's position exasperating and obstructionist. Even MELCO officials claimed that its T/R modules were based on dual-use technology and that many other similar types of modules were under development or in production for commercial applications. Indeed, spin-on of commercially developed processes from the development and manufacture of related commercial components was the key to MELCO's dual-use strategy. MITI countered that, since MELCO did not use the specific T/R module developed for the FS-X APA radar in any commercial product, and JDA had paid for at least a portion of its development, the module had to be classified as military hardware incorporating military technology. Although the same argument could be made in the case of the cocured composite technology MHI used on the FS-X wing, MITI officials claimed that that technology could be treated as dual-use because the European Airbus consortium used similar processes for the rudder of its new A320 airliners. By the same line of reasoning, MITI considered the specific design and unique tooling for the FS-X wing to be military technology.²⁵

U.S. officials soon developed a compelling counterargument to MITI's position on the modules. They pointed out that many Japanese companies served as major parts suppliers to U.S. manufacturers of military combat aircraft. They noted, for example, that

²⁴Interviews with Japanese MITI officials, Tokyo, June 18, 1992, and with a U.S. Air Force officer, December 18, 1991.

²⁵Interviews with Japanese MITI officials, Tokyo, June 18, 1992, and with a U.S. Air Force officer, December 18, 1991.

JAEI, the leading Japanese military avionics firm, sold items such as accelerometers and gyros to McDonnell-Douglas for installation on the F-15 fighter. These specific items were only used on military aircraft. U.S. officials asked the Japanese why MITI considered these items to be dual-use technology and permitted their export to the United States, yet had ruled that MELCO's T/R modules were military technology even though the Japanese company insisted they were based on dual-use technology and claimed to make several similar items for commercial applications. "MITI got caught on this one," according to one American official.²⁶

However, some American officials expressed serious reservations about pursuing this line of argument much further. They doubted that helping Japanese firms punch holes in their government's strong barriers against arms exports served the best interests of the U.S. government and defense industry. Indeed, MELCO was actively lobbying the Japanese government to reclassify the T/R modules, or at least the underlying technology, as dual-use to open up the export market, not just to transfer technology to the United States within the context of the FS-X program. Although MELCO claimed it only wanted to export the MMIC chip and other basic component technology for possible civilian applications, the situation nonetheless caused some concern on the U.S. side.²⁷

The Americans decided to adopt a less potentially controversial strategy by arguing that a limited purchase of T/R modules for testing purposes represented simply an aspect of military data transfer. Unfortunately, the FS-X accords did not require the Japanese to transfer sample test items to the United States to facilitate technology transfer. Rather, they only dealt with the U.S. right to test nonderived items in Japan at American expense. Therefore, the U.S. side based its request on the 1985 Detailed Arrangements for the Transfer of Military Technologies, in which the Japanese had agreed to provide "articles which are necessary to make transfer of the military technology effective." (OUSDRE, 1986, Tab C, p. 2.) MITI and JDA, however, raised questions about the precise meaning of this phrase and whether it applied in the

²⁶Interview with a U.S. official at MDAO, Tokyo, June 17, 1992.

²⁷Interview with a U.S. Air Force officer, July 30, 1993. Also see "Mitsubishi Electric Considering Exporting FSX Radar Technology" (1992) and "Defense Industry Watching Issue as Test Case" (1992).

case of the T/R modules. The Keiko SAM, which had been approved in principle for testing in the United States in the mid-1980s but never actually transferred, was used as a precedent to try to convince JDA officials.²⁸

JDA's continuing reluctance to provide more test and cost data on the T/R modules combined with MITI's reservations about the sale or lease of modules to the United States spurred the American side to press even harder for a clarification of the procedures and definitions for technology transfer in the negotiations over the TTP annex of the FS-X IA. The renewed high-level administration pressure for greater defense technology cooperation, capped by President Bush's trip to Tokyo in January 1992, may have helped convince the Japanese to accept the revised wording for the TTP the Americans had developed. In February 1992, nearly three years after Japan agreed to the Bush administration's clarifications on technology transfer and two years after the completion of the FS-X technology transfer implementation agreement, the Japanese finally approved the revised TTP. This document included a more expansive definition of technology transfer and related terms intended in part to aid U.S. efforts at acquiring more data on MELCO's radar and other Japanese nonderived technologies.²⁹

The TTP helped establish a stronger legal framework for U.S. purchase of MELCO's T/R modules by broadening the definition of technology and data transfer beyond that in the 1985 Detailed Arrangements. Among other things, the Japanese had now apparently accepted the principle that the U.S. government could negotiate the purchase of limited numbers of military hardware items within the context of the FS-X program to enhance data transfer and assessment of the underlying technology for possible future transfer. This interpretation left intact Japan's long-standing prohibition against military hardware exports to all countries, including the United States. MELCO could still not export T/R modules or any other hardware classified as military technology for use in U.S. production weapon systems. Indeed, such items could not even be exported to the United States for GD's use during the fabrication of the FS-X prototypes. The export of small numbers of

²⁸Letter to the author from U.S. Air Force officials, November 1, 1993.

²⁹"FSX Not Keeping Its Promise as Technology Cornucopia for U.S." (1992).

T/R modules was justified exclusively as a means of facilitating technology transfer and was applicable only to the FS-X program.³⁰

By this time, considerable progress had also been made on a variety of other initiatives designed to interest American industry in Japanese nonderived technology. Plans for holding a symposium on the radar for U.S. industry representatives began firming up. JDA and MITI still remained unenthusiastic, however, arguing that neither the TTP nor any other document called for this type of mechanism to promote technology transfer. JDA did not want to accept the general principle of holding numerous technology symposia in the future. Nonetheless, MELCO and other Japanese avionics companies continued to be much more supportive of the idea, viewing it as a useful marketing forum. Eventually, JDA came to the position that it would have no objections to the symposium if Japanese industry had none.³¹

Meanwhile, the two sides were also nearing agreement on a sanitized version of the trip report from the second radar visit for distribution to U.S. contractors. The U.S. government version had been completed in late 1991 and submitted to the Japanese for approval. In January, the Japanese returned their marked-up draft. For several months thereafter, the two sides argued over deletions the Japanese made but eventually reached agreement on a final version. By this time, the Japanese had also finally accepted the symposium idea, and a June date had been established. Officials decided to distribute the sanitized radar report to industry at that forum. U.S. officials also planned to complete a special pamphlet and a white paper for distribution at the radar symposium explaining U.S. access rights, definitions of terms, and procedures for technology transfer. Finally, the U.S. side had also won agreement from the Japanese in February 1992 to include representatives from U.S. industry on future visits by government technology assessment teams, and planing for such visits got under way.³²

³⁰Interview with a MITI official, June 18, 1992. Also see GAO (1992), p. 20.

³¹Letter to the author from U.S. Air Force officials, November 1, 1993.

³²Written communication from a U.S. Air Force official, June 30, 1993. This right is included in the revised TTP.

The FS-X Radar Technology Symposium in Washington

Hosted by DoC, with cosponsorship from DoD and the U.S. Air Force, the *FS-X Radar Technology Symposium* held in Washington on June 22, 1992, represented the culmination of many months of intensive effort by U.S. officials committed to finding new and creative mechanisms for promoting the transfer of nonderived technology to U.S. industry. American companies had been informed about the symposium well in advance through announcements in the *Commerce Business Daily* and through industry associations. Approximately 200 representatives from about 50 major U.S. defense contractors attended the symposium. Nearly all the leading contractors specializing in airframe development and integration, military radars, and other major avionics systems participated. The Japanese side included MELCO radar experts and observers from JDA and the Japanese Embassy. U.S. program officials presented briefings on the overall program, technology transfer and flowback provisions, Japanese export policy, and technical aspects of the radar and the other three nonderived avionics systems. In the afternoon, MELCO officials briefed the audience on the APA radar, the T/R modules, and MMIC developments.³³

U.S. industry reaction to the symposium was mixed. Most attendees felt government officials had put together a well-organized and informative day of briefings. Some believed, however, that MELCO had provided insufficient technical detail on its radar and component technologies. Others found MELCO's presentations useful but were confused by the amazingly complex provisions and procedures relating to FS-X technology transfer. One observer complained that few lower-tier U.S. vendors who might have benefited from access to MELCO's basic technologies and processes attended the meeting. Some engineers representing leading U.S. military radar developers continued to express skepticism about the potential value of MELCO's radar technology for U.S. military applications. One expert pointed out that MELCO's T/R modules "are less advanced than those made by Texas Instruments," the principal developer of the T/R modules for the U.S. Air Force F-22 fighter radar (Leopold, 1992a). Another "industry source" argued

³³See Lachica (1992); and "FS-X Technology Symposium" (1992).

that, although active array technology was supposed to provide superior performance at less weight, the Japanese radar “does not represent a significant reduction in weight” compared to the Hughes APG-68 radar for the F-16 using older technology (Leopold, 1992b). Yet, despite such skepticism, the symposium did spur further interest from a few American companies.

Following the symposium, Hughes Aircraft Company, Westinghouse Electronic Systems, and other American companies did indeed open discussions with MELCO. Texas Instruments, however, apparently was not among these companies. According to press accounts, Hughes and Westinghouse primarily sought access to low-cost Japanese manufacturing processes for GaAs MMIC devices and T/R modules to help them compete with Texas Instruments. Although they apparently recognized that American active array technology was more advanced than MELCO’s, they had left the symposium greatly impressed with the Japanese company’s extensive experience with manufacturing large numbers of different types of commercial modules.³⁴ They seemed interested in expanding their expertise in manufacturing a wide variety of MMIC devices for both commercial and military applications. Although these contacts continued through 1992 and into the next year, no specific agreements for the actual transfer of technology had been reported by mid-1993.

A Purchase Agreement for T/R Modules Is Sealed

During this same period, government negotiators also achieved considerable success in their efforts to obtain more detailed data on MELCO’s module technology. Serious detailed negotiations for the U.S. government purchase of T/R modules for testing purposes began in early 1992. After the approval of the TTP, these negotiations progressed reasonably well, although some problems arose on both sides. U.S. negotiators had to find money that could be used for purchasing and testing the modules. JDA and MITI wanted to impose some restrictions on what U.S. government technicians

³⁴In 1991 Hughes and Delco reportedly successfully began manufacturing an 8-W second-generation T/R module—a far higher power rating than MELCO’s FS-X radar module—for possible application in future versions of the F-15 and F-18. See “Hughes Moves to Cut Active Radar Costs” (1992).

could do with the modules during testing and evaluation. In particular, the Japanese did not want American experts to break down or disassemble the modules. Pentagon officials agreed to this restriction. By January 1993, an agreement in principle for purchase of the modules had been struck.³⁵ But a variety of other contracting issues delayed final implementation. After several more months of discussions, a final agreement was concluded. According to at least one program official, "this experience was upbeat—MELCO was extremely cooperative."³⁶

In mid-1993, program officials publicly revealed that MELCO would sign the final agreement in July for the sale of five sample T/R modules to the U.S. government. The U.S. Air Force microwave division at Wright-Patterson Air Force Base planned to begin testing the MELCO modules in late July or early August. The U.S. government paid less for each MELCO module than the unit cost of the much higher-performance Texas Instruments modules used in the ATF prototype dem/val program but considerably more than for the higher-performance modules Hughes developed in 1991. The key to the deal had been the "packaging" of the request to purchase modules as a necessary component of transferring data needed by the United States to assess the technology for possible transfer at a later date. According to one JDA official, "this [technical data agreement] is not technology transfer per se." He explained that "the data are the main point." (Leopold and Usui, 1993b.)

Successful purchase of the MELCO T/R modules for testing in the United States is rightly viewed by many program officials as a significant achievement. However, it remains uncertain whether the original questions the Pentagon posed can be answered with the data the Japanese provided or whether that will emerge through testing. The Japanese data package included interface control data and some production-lot test data. It did not include all Japanese evaluation test data or design drawings and methodologies (Oda, 1993a). The Japanese had also not provided data on module production costs or on low-cost, high-rate manufacturing processes. Most of the government testing in the United States was expected to focus on performance characteristics. Therefore, it

³⁵"Japan in New Agreement to Provide FSX Radar Technology to U.S." (1993).

³⁶Letter to the author from U.S. Air Force officials, November 1, 1993.

remained doubtful that American examination of the T/R modules would yield much additional information on manufacturing processes or costs, the stated area of primary DoD interest.

OTHER NONDERIVED SYSTEMS AND THE JAEI TECHNOLOGY SCANDAL

Despite the shortcomings in the data acquired from the Japanese, many program officials viewed the T/R module purchase agreement as establishing a major precedent in U.S.-Japan defense technology cooperation. The American side did not initially achieve comparable success in gaining access to data on the other three indigenous avionics systems, but this was understandable, since these systems were in far earlier stages of development than the APA radar. Yet by mid-1993, considerable progress had been made in these areas too. As early as December 1991, the Pentagon had sent a TAT to Japan to learn more about the FS-X MC. A follow-up visit took place in May 1993. Two months later, U.S. officials visited Japan for their first formal examination of the IEWS. The initial visit for the IRS was scheduled for November 1993. Additional visits were being planned for 1994. It is still unclear, however, whether these other three nonderived systems embody any technologies of interest to the U.S. government or industry.³⁷

The MELCO Mission Computer and Integrated Electronic Warfare System

TRDI and Japanese industry had conducted basic studies and R&D on an advanced airborne computer dating back to the early 1980s. However, the development of the FS-X MC did not begin until late in the decade. MHI awarded the contract for the design of the FS-X MC to MELCO, which also received the contract to develop the computer software. NEC and Hitachi were tasked with developing many of the key hardware components. By the end of 1991, MELCO had delivered a breadboard prototype MC to MHI. The DoD team examined this prototype during its initial visit in

³⁷Letter to the author from U.S. Air Force officials, November 1, 1993; written communication from another U.S. Air Force official, June 30, 1993; and GAO (1992a), pp. 22-23.

December. The information gained by the U.S. side proved disappointing, however, primarily because key design decisions still had to be made prior to developing a more advanced engineering model for ground and flight testing (GAO, 1992a).

American experts initially concluded that the MELCO MC, while exhibiting some improved performance and memory characteristics, represented a relatively modest development effort that would result in a system roughly comparable to the existing F-16 computer. Some team members believed that the incorporation of NEC's dual-sided, surface-mounted component boards, apparently a dual-use development derived from commercial applications, might ultimately cause problems with cooling the MC. They speculated that U.S. industry might consider any solutions MELCO found for this problem interesting. Component manufacturing technology also emerged as a potential candidate for technology transfer, primarily due to NEC's strong reputation for low-cost, high-quality mass production in the commercial sector.³⁸ However, the same question with the T/R modules that worried U.S. officials about the transferability of Japanese industry philosophy to the different U.S. industry structure seemed also to apply in this instance.

In March 1992, JDA officially announced that MELCO would also develop the IEWS. Although some earlier studies had been conducted, the actual prototype hardware and software design effort only started at about this time, with delivery of the first prototype not scheduled until the end of 1993 (Ebata, 1993, p. 462). Thus, U.S. information on this system and its embedded technology remained sketchy.

The JAEI Scandal and Its Effects on the IRS and Flight-Control Computer System

Full-scale development of the fourth nonderived system, the IRS, as well as the important flight-control computer system, got off to a particularly rocky start because of a serious political controversy involving JAEI that first surfaced in mid-1991. The controversy in many respects paralleled the infamous Toshiba incident in 1987 involving the illegal sale of dual-use technology to the

³⁸Interview with a U.S. Air Force officer, December 18, 1991.

Soviet Union that many observers believe provided the United States the political leverage necessary to compel Japan to develop the FS-X cooperatively.

Controlled by NEC, one of Japan's largest electronics companies, JAEI is the country's most important supplier of military avionics. It enjoys a virtual monopoly position as a JDA supplier of numerous key components for almost all military aircraft built in Japan. By the early 1990s, it had become a world leader in ring laser and fiber-optic gyroscopes, as well as in flat-panel displays. JAEI was expected to lead the development of the FS-X IRS, as well as the development of the flight-control computer. However, in early July 1991, press accounts revealed the company was under investigation by the U.S. Customs Service for criminal export-control violations. U.S. officials accused JAEI of illegally exporting gyroscopes and inertial navigation systems built under license from Honeywell to Iran in the mid-1980s for incorporation into its American-built Iranian F-4 Phantom fighters during the Iran-Iraq War.³⁹ In addition, investigators claimed that, in 1988 and 1989, the company had also illegally sold licensed-produced components for the American AIM-9 Sidewinder air-to-air missile to Iran (Usui, 1991d).

The resulting JAEI scandal illuminated several interesting aspects about Japanese technology developments for the FS-X. First, it revealed that at least some of the Japanese indigenous avionics systems heavily depended on American components or technology, while other systems classified as derived were being developed mainly by the Japanese with U.S. assistance as largely all-new systems. Second, the JDA reaction to the U.S. restrictions placed on JAEI confirmed once again how completely committed the *kokusanka* supporters remained to maximum indigenization of the FS-X technologies.

In August, MITI launched an investigation of JAEI for possible violations of Japan's export prohibitions. JDA soon followed with a ban on further procurement from the company of all but critical items. Late in the month, Japanese authorities arrested four senior JAEI executives for violating foreign exchange and customs

³⁹Iran had purchased the F-4s from the United States prior to the overthrow of the pro-American Shah in 1979. Ironically, the White House also allegedly arranged for the clandestine export of military equipment to Iran in the mid-1980s using Israel as a conduit.

laws and later filed criminal charges against them. In September, U.S. authorities also filed criminal charges against the company. The U.S. Department of State responded by suspending all license agreements with JAEI and banning further U.S. business with the company.

These actions caused several potential problems for the FS-X IRS and flight-control computer. JDA's ban, undoubtedly at least partly a preemptive response to anticipated U.S. political reaction to the scandal, raised doubts about awarding the full-scale development contract for the IRS to JAEI.⁴⁰ Even worse, JAEI planned to use important U.S. components in the IRS, such as integrated circuit boards and data buses from U.S. companies. The situation was even worse for the flight-control computer, the software for which had been the subject of considerable controversy in 1989. Following the U.S. decision to prohibit transfer of the F-16 flight-control computer source codes during the clarification process, JAEI had been tasked with designing and integrating a new computer system for the FS-X in Japan. MHI had won responsibility for developing the flight-control laws and writing the source codes. But the U.S. firm Bendix Flight Systems (Allied Signal) had also been subcontracted to provide the central processor and input-output processor boards, key components of the computer. The Department of State ban on continued business with JAEI thus threw the development plans for these two critical avionics systems into disarray (see Usui, 1991c).

Japan Reacts to U.S. Sanctions

The U.S. suspension of export licenses to JAEI provoked a storm of protests from JDA and Japanese industry. They pointed out that the ban could adversely affect nearly every major Japanese military aerospace program. It is also important to remember that the JAEI problem arose at the height of the dispute over the Japanese request for transferring licensed-production data on 122 components to permit Japanese industry to manufacture items for the FS-X prototypes (see Chapter Ten). Not surprisingly, many Japanese observers used the Department of State restric-

⁴⁰JAEI had received a contract to conduct basic R&D on fighter IRSs but had not yet been awarded the full-scale development contract for the FS-X system.

tions on JAEI to bolster their arguments for greater defense industry autonomy through increased national military R&D efforts. As one industry spokesman complained, the U.S. action against JAEI proved "Japan is more under the American license umbrella than the nuclear umbrella."⁴¹

Although MHI immediately began seeking new subcontractors to replace JAEI, it soon became evident that no other company in Japan possessed the necessary skills and know-how to lead development of the IRS and flight-control computer. Some American officials sought to exploit this situation by arguing that the only viable remaining option was to hand over development of the flight-control computer solely to Bendix. Since the hardware and software developers of the flight-control system needed to work closely together, this solution would require the American company to interact extensively with MHI computer programmers. Such a collaboration, however, might be viewed as a violation of the 1989 clarifications. Therefore, the Bendix solution could also possibly lead to an approach that even went beyond what had been pushed so hard by the Americans in 1989: development of the entire flight-control system, including the computer and the software, in the United States with no technology transfer to Japan (Usui, 1992).⁴²

JDA and Japanese industry officials remained unbending in their opposition to this solution. According to one Japanese analyst, forcing JDA "to pick an American vendor to build the FS-X's auto pilot system" would be considered "the worst scenario." (Also see Chapter Nine.) Instead, Japanese government officials pressed the Americans hard for special waivers and exceptions to the Department of State trade ban on specific critical items, including those needed for the flight-control computer and the nonderived avionics systems. JDA and industry officials conducted extensive negotiations with the Department of State, the Department of Justice, and DSAA in late 1991 and early 1992, but progress toward a solution was slow. Eventually, however, the two sides finally struck a deal. On March 11, JAEI officials pleaded guilty to the U.S. charges in a Federal District Court in Washington. The court imposed a \$10 million criminal fine, purportedly the largest

⁴¹Quoted in Usui (1991c), p. 18.

⁴²Also see Chapter Eight.

of its type ever exacted. In addition, JAEI agreed to pay the Department of State \$5 million in administrative penalties. In return, however, JAEI won the crucial concessions it had been seeking in an out-of-court settlement: removal of the ban on sales to JDA and the United States and the lifting of the suspension on current licensed-production agreements. Nonetheless, the Department of State imposed a one-year ban on new license agreements with the company.⁴³

The long-term effect of this settlement on the development of the IRS and the flight-control computer remained uncertain. Some observers suggested that JAEI would still seek to increase the role of Bendix in the development of the flight-control computer because of R&D delays caused by the scandal and continuing problems with software development.⁴⁴ Nonetheless, it appears that Japanese pressure had effectively blocked the move to change the computer and its source codes to a black-boxed end-item developed and supplied by a U.S. company. JAEI's continued indigenous development of the high-technology aspects of the IRS, such as the software, accelerometer, and ring laser gyro—based in part on years of experience working with Honeywell—would probably not be affected by the settlement. More would be known following the visit of a Pentagon TAT scheduled for October 1993.

The JAEI episode provided a glimpse of how dependent some of the nonderived avionics systems were on American parts, components, and technology. But the problem with the flight-control computer also revealed that some systems designated as derived did not dramatically differ in their development and the origin of the embedded technology from the nonderived systems. Bendix was providing key components for the flight-control computer, but the overall system was essentially being designed, developed, and integrated in Japan. In certain respects, the flight-control computer represented a unique situation because of the 1989 controversy over U.S. transfer of the source codes. Yet, as indicated by the request in mid-1991 for licensed-production data and rights on 122 other FS-X items, the Japanese were moving toward indigenous manufacture, modification, or development of a broad spec-

⁴³Sanger (1992); GAO (1992a), p. 23, fn 2.

⁴⁴"Japanese Military Sees Joint FSX Program as Troublesome but Necessary" (1992).

trum of components and major parts for the FS-X. Thus, the ultimate national origin of the various technologies embodied in both derived and nonderived systems and components was becoming increasingly blurred. As the FS-X evolved further in the direction of a largely Japanese-developed fighter, frictions were bound to arise with the Americans over the categorization of items other than the four avionics systems as derived, as well as the question of free and expeditious transfer of all derived technology to the United States.

Overall, then, the determined and persistent efforts by U.S. officials to gain access to, and promote the transfer of, Japanese non-derived technology met with only mixed success during the first three-and-a-half years of the R&D program. The principal explanation for this, according to some U.S. program officials, is simple: Insufficient technical data existed on the Japanese side to support an assessment by the Americans. With the exception of the radar, these officials point out, the Japanese had conducted very little system testing on the other three nonderived items, and the basic technology was still under development. Nonetheless, it is undeniable that the U.S. side often met with resistance and roadblocks from JDA, MITI, and Japanese industry in its quest to gain access to data on the APA radar, a much more mature system.

Still, the U.S. side also won some notable successes. Most prominent among these were the MELCO radar symposium held in June 1992 and the Japanese agreement to permit purchase of five MELCO T/R modules for testing in the United States. It does not appear likely, however, that this testing will reveal much about MELCO's production costs and manufacturing processes. And no major agreements between U.S. and Japanese firms for the transfer of radar-related technology have yet appeared in the press.

DERIVED TECHNOLOGY AND THE QUESTION OF CATEGORIZATION

By mid-1993, virtually all the legalistic issues relating to derived technology flowback were in the process of a possible broad transformation because of the trend toward increasing application of Japanese technology to the program that emerged after 1990. This trend could ultimately greatly affect U.S. access rights to

FS-X technology, and could potentially cause major problems with the negotiation for the production agreement for the program.

It will be recalled that, beginning with the renegotiation of the MoU for the licensed production of the F-15 in 1984, all U.S. weapon-production agreements with Japan included a standard provision requiring the free and automatic flowback of all improvements and modifications "essentially derived" from U.S. technology. Prior to 1991, however, virtually no technology flowback from a licensed-production program had actually occurred. In December of that year, KHI agreed to transfer an improvement to the electrical generation system on the P-3C Orion antisubmarine warfare aircraft it was building under license from Lockheed. Four months later, U.S. officials announced a second deal for the possible transfer of flight-control computer technology KHI had developed for the P-3C. These successes resulted in part from the renewed emphasis senior Bush administration officials placed on greater technology reciprocity with Japan beginning in the fall of 1991 (Wanner, 1992, p. 5).

The situation with the FS-X, however, was considerably different and much more complicated because of the extensive modifications to the baseline F-16. Only four technologies, as represented by the four Japanese indigenous avionics systems, had been explicitly classified as nonderived in the original agreements. The FS-X accords required the free and expeditious flowback of all derived technology, which as defined in the original agreements applied to every technology incorporated into the aircraft other than those directly related to the four indigenous avionics systems. However, the agreements also included procedures for considering the change of classification of a technology from derived to nonderived at Japan's request as the R&D program progressed.

After an initial start-up period, the process of transferring derived data back to the United States appeared to be working reasonably well. In mid-1991, MHI began transferring large quantities of documents and other data to GD that were primarily related to the design and development of the wing and the rest of the airframe. By the middle of 1992, GD had received approximately 3,000 of these, about one-quarter of which related to the composite wing. The other 2,300 or so data items applied to other aspects of the airframe or support equipment categorized as derived tech-

nology.⁴⁵ Two years later, the total data items received from Japanese industry stood at well over 16,000.⁴⁶

Nonetheless, the Japanese were not completely satisfied with this situation. They had never considered many of the technologies associated with the wing and other aspects of the fighter to be derived. U.S. working-level officials recognized that items such as the composite wing had been treated as derived technology from the beginning, principally in response to U.S. domestic political pressures, not because of any careful determination that the wing was based on U.S. technology. The original effort to limit non-derived technology clearly to the four indigenous avionics systems had been primarily a product of the interagency review and clarification process and the congressional debates in 1989. During the negotiations for the MOIA that followed in the fall of 1989 to tighten up U.S. access rights, many American program officials had argued for including procedures for technology reclassification, which had in fact been carried out.

Probably the most unsettling aspect of this issue for U.S. working-level officials, however, was the unpleasant prospect of provoking a strong negative political reaction in Congress and elsewhere if a significant number of FS-X technologies were reclassified. Reclassification could be viewed by political opponents of the program as an attempt by Japanese industry to limit U.S. access to FS-X technologies, to permit the commercialization of technologies that had been originally acquired at least in part through earlier licensed-production programs, and to build up further a national military aerospace capability. Furthermore, senior Bush administration officials had repeatedly stressed the limitation of non-derived technology to the four Japanese avionics systems when selling the FS-X deal to Congress.

Nonetheless, by the end of 1991, U.S. officials agreed to open working-level discussions on the possibility of reclassifying some items as nonderived technology. The Japanese fully recognized that the wing was a special case and particularly sensitive politically. They decided to submit a clear-cut test case of the reclassification process in an area other than the wing. In the mid-1980s,

⁴⁵Interview with a U.S. industry official, August 4, 1992; and with Japanese industry officials, Nagoya, June 15, 1992.

⁴⁶Letter to the author from Lockheed Fort Worth, March 9, 1994.

MHI had begun an R&D program to develop special radar absorbent materials (RAMs) to reduce the radar cross section of the FS-X to make it more stealthy. Mitsubishi had persistently refused to transfer data on this technology to GD, arguing that it indisputably represented a wholly indigenous development.⁴⁷ In July 1992, the Japanese made their first formal request for reclassification, using RAM as the test case. U.S. program officials proceeded very carefully on this issue. In February 1993, the U.S. government approved a change of MHI's RAM technology from derived to nonderived.⁴⁸

At about this same time, other newspapers in Japan and the United States began reporting that between 30 and 40 lower-tier Japanese companies were objecting to the classification of their products as derived. Reportedly, these products accounted for about 50 out of the roughly 200 subsystems and major components for which MHI had subcontracted to lower-tier vendors. Items mentioned in the press included a liquid cooling system for the radar, wing-flap actuators, air-regulating equipment, and the HUD, all developed by the Shimadzu Corporation; Yokogawa's liquid crystal multifunction displays; and RAMs.⁴⁹

In late February, the Japanese head of the FS-X program, General Matsumiya, seemed to confirm these reports when he told American reporters during a visit to GD's facilities in Fort Worth that JDA was considering a request to reclassify a number of FS-X technologies as indigenous. He pointed out that "derived and non-derived technologies are not all defined yet." He explained that Japan was only now selecting suppliers on a large scale for major subsystems and components. "As a result of these source selections," he continued, "there might be some increase in non-derived technologies." General Matsumiya insisted that there was "no political issue" surrounding this question. Rather, it was the natural result of the technological evolution of the program.⁵⁰

⁴⁷The United States had never permitted the transfer of RAM technologies to Japan.

⁴⁸Interview with a U.S. Air Force official, June 9, 1993.

⁴⁹For example, see "Japan May Seek Expanded List of FSX's 'Non-Derived' Technologies" (1993); Leopold and Usui (1993a); and Bailey (1993), p. 17. In Japan, major articles appeared in the financial daily *Nihon Keizai Shimbun* on February 23 and in Tokyo's *Nikkei Sangyo Shimbun* on February 25.

⁵⁰All quotations from Towle (1993), pp. 1, 9.

This last point represents the key to understanding the whole question of technology categories on the FS-X program and the problem of free and expeditious flowback. This issue was particularly well-stated by a leading Japanese daily in early 1993. As a lengthy front-page article explained (Oda, 1993b):

[I]n the United States there is a deep-rooted perception that the FS-X is nothing more than a reconstructed F-16. Thus, the various advanced technologies emerging from the process of developing the FS-X are expected to be returned gratuitously from Japan in compensation for handing over the F-16 technologies.

Nevertheless, in Japan there are still some who expect the FS-X, a project that started out as a purely domestic development effort, to be the "reincarnation of the Zero."⁵¹ In the technical ranks of Mitsubishi Heavy Industries, there is strong speculation that "the FS-X is not a revamped F-16 but rather a new fighter plane."

⁵¹A reference to the highly successful Mitsubishi A6M Zero-Sen, the most famous Japanese fighter of World War II, first encountered by the Americans at Pearl Harbor. The A6M entered production in 1940, the year 5700 according to the traditional Japanese calendar. Consequently, it became popularly known as the Type 00 fighter, or Zero-Sen.

**AN INTERIM TECHNOLOGY
BALANCE SHEET**

INTRODUCTION

The question of which side would benefit most from the transfer of technology and expertise stood at the very heart of the public controversy surrounding FS-X during 1989. Program opponents argued that America was selling its advanced aerospace technology for short-term financial gain, while contributing in the long run to the emergence of a new and formidable competitor in the commercial aerospace industry. FS-X supporters rejected this view, claiming that the F-16 data transferred to Japan had little relevance for the commercial aerospace sector. Furthermore, they pointed to the potential transfer to American firms of advanced Japanese technologies that might prove highly beneficial in both the defense and commercial arenas.

After several years of actual full-scale R&D activity on the FS-X, it is now possible to offer an interim assessment of the likely net economic and technological benefits of the program based on actual experience. Although it is still far too early in the program to make a definitive judgment, the evidence to date indicates that neither side will gain dramatically from the direct transfer of technology through the program. However, the evidence also suggests that the whole debate over technology transfer winners and losers in 1989 ignored the true technological significance of the program for Japan. The Japanese military aerospace industry is clearly the big winner but not primarily because of the transfer of U.S. technical data. Rather, the real significance of the FS-X program arises

from Japanese industry's success pursuing many of the original technological objectives of indigenous development within the more restrictive framework of a collaborative program for the development of a modified U.S. fighter.

This chapter briefly reviews the balance of technology transfer as of the end of 1993 and some of the economic benefits to the United States; it then turns to the more important issue of long-term technological benefits to the Japanese defense industry. The chapter then argues why continuation of the program into full production is so important for U.S. interests, and it concludes with a discussion of how to make the program work better in the future.

TRANSFERRING U.S. TECHNOLOGY TO JAPAN

At the center of the FS-X debate in Congress was intense concern about the negative effects on U.S. employment and the long-term economic competitiveness of the American aerospace sector of massive technology transfer to Japan. Clyde Prestowitz's influential *Washington Post* article, "Giving Japan a Handout," had defined the parameters of the debate in 1989 by dramatically giving voice to these concerns (Prestowitz, 1989b):

[The FS-X deal] will transfer technology developed at great expense to U.S. taxpayers at very low cost to a country whose primary interest is not defense but catching up with America in aircraft and other high-technology industries [T]he United States could be creating a powerful competitor in its best export industry for a relative pittance in subcontract fees.

Despite the Bush administration clarifications to the original FS-X deal, Prestowitz's views remained widely held. Three years later, after full-scale development of the FS-X was well under way, many commentators would have still agreed with one GD union leader who argued at that time that cooperative deals like the FS-X are equivalent to "selling off an industry built and financed by taxpayers" to future foreign competitors (Towle, 1992a). As one U.S. Air Force program official said the same year, "we have sold Japan the

blueprints for making one of the world's best tactical fighters for a mere \$60 million."¹

It is virtually impossible to measure the specific benefit to Japanese industry or any possible long-term damage to the U.S. aerospace industry from the transfer of the F-16 TDP and related data to Japan. Yet after the experience of several years of R&D on the FS-X program, it appears that the concerns about "selling off" the U.S. aerospace industry were overblown. The testimony that many technical experts presented during the 1989 congressional hearings—that the transferred F-16 technology would have little direct application to commercial aircraft and the development of a commercial aerospace sector—appears largely correct. Most aerospace technical experts would agree with this assessment.

What is even more certain is that the actual transfer of F-16 technical data during FS-X development has been subjected to a level of scrutiny and restrictiveness unprecedented in the history of U.S. cooperative aerospace programs. As a result of the 1989 debate, the whole question of technology transfer assumed a high political profile. The active involvement of the DoC and the subsequent interagency review produced explicit and detailed guidelines for controlling the transfer of technology that in some cases went beyond the already strict controls routinely applied by DoD through its normal procedures.

Because of the political sensitivity of technology transfer, the GAO has focused a great deal of attention on it during its regular program reviews. For example, nearly half its mid-1992 report was taken up with an extensive assessment of the entire technology transfer process (GAO, 1992a, Chs. 3 and 4). The GAO investigators carefully examined how well Air Force officials at the F-16 SPO had handled the review of the nearly 11,000 items in the F-16 TDP and other supplemental data collections, as well as the Pentagon's procedures for approving export licenses for the FS-X program.

The GAO concluded that "the United States has adequately controlled the release of F-16 related data to Japan." (GAO, 1992a, p. 26.) The report's authors observed that "the existing data release process has been rigorously applied to the FS-X program, and

¹Interview with a U.S. Air Force officer, Wright-Patterson Air Force Base, June 1, 1992.

certain release decisions have received increased attention and consideration." (GAO, 1992a, p. 32.) GAO noted that GD officials had "expressed concern about the overly restrictive nature of the U.S. government's data release policy." (GAO, 1992a, p. 31.) What the report failed to mention was that some working-level Air Force officers had also complained about the slow, complicated, and excessively restrictive review process involving DTSA, DSAA, the Department of State, and even outside contractors. Some observers argued that the basic technology review guidelines applied to the FS-X program, which called for holding data transfer to an "absolute minimum" consistent with existing agreements, resulted in the withholding of nonsensitive data and could adversely affect the schedule and cost of the program.²

However, regardless of whether or not the review process was overly restrictive, it probably did not significantly delay the R&D program. In the end, the U.S. government released the vast bulk of applicable program data to the Japanese.³ But clearly the release of technology for the FS-X program has been rigorously controlled. In the case of the F-16 European coproduction program launched in the mid-1970s and most other licensed-production programs prior to 1985, most of the specific decisions on what technology to release were made by uniformed technical experts at the weapon-system program office. On the FS-X program, Pentagon agencies, led by DTSA and DSAA, played significant and sometimes dominant roles in release decisions. In general, these two DoD authorities, particularly DTSA, leaned toward the strictest

²Interview with a U.S. Air Force officer, Wright-Patterson Air Force Base, June 1, 1992.

³According to GAO figures, the U.S. government denied the release of only about 5 percent of the 10,550 data items in the F-16 TDP. Another 2 percent were released but required modification. In September 1990, MHI requested release of 251 previously denied items. After reviewing these items a second time, the U.S. government permitted the transfer of 20 percent of them, of which half required "sanitization." The U.S. government also approved 74 percent of the 631 F-16 supplemental data items requested by Japan. As of March 1991, GAO had identified 75 export licenses outside of the F-16 TDP but related to the FS-X program that had been approved by the Department of State and the Pentagon. See GAO (1992a), pp. 26, 29, 33.

interpretations of the technology-release guidelines established for the FS-X program.

Because of this strict review process, and the extensive technology restrictions that resulted from the 1989 interagency review, it is highly unlikely that Japanese industry is acquiring many specific technologies related to the F-16 that it has not already received through the F-15 program or other past licensed-production deals. Indeed, during the ongoing FS-X development phase, U.S. officials have already denied Japanese industry licensed-production rights for technologies and components it had already gained access to on prior programs. As the GAO report points out, "the FS-X program receives a great deal of attention within existing disclosure release channels because of the program's high visibility." (GAO, 1992a, p. 32.) This attention has led to an extremely conservative approach to technology-release decisions.

Thus, the GAO is undoubtedly correct in concluding that U.S. government control of technology transfer to Japan on the FS-X program has been adequate. Indeed, one could argue that it has been too strict. It seems certain that the U.S. denial of rights for licensed production of certain components and technologies in Japan during the FS-X R&D phase has encouraged even greater indigenous development by Japanese industry.

BENEFITS TO U.S. INDUSTRY

To help counter the widespread criticism in 1989 that the FS-X deal amounted to a massive giveaway of U.S. aerospace technology, administration supporters heavily emphasized the many benefits—mainly money, jobs, and technology—the program would provide to U.S. industry. Access to Japanese technologies, especially manufacturing technologies related to the APA radar and the cocured composite wing, came to symbolize the new era of technological reciprocity with Japan. Since the beginning of actual R&D, U.S. program officials have worked hard to implement the politically charged economic components of the FS-X agreements, particularly with respect to U.S. workshare during R&D and access to Japanese technologies.

Revenue and Jobs

Three years into the actual R&D effort, U.S. officials have had many successes to show for their efforts. As of mid-1993, U.S. industry was actually receiving more than its mandated 40-percent share of the official R&D budget, which on completion was expected to surpass \$1.1 billion.⁴ American industry's guaranteed share of 40 percent of any production work could bring in \$2 billion or more. Of course, the American share is calculated only in terms of the official government FS-X budget, not actual R&D costs, which may be much higher.

This development work and income from Japan are certainly welcome at a time when Pentagon and business leaders are struggling to maintain the economic viability and technical capabilities of the U.S. military aircraft sector in the face of rapidly declining American defense budgets. Nonetheless, the relatively modest scale of the U.S. side of the FS-X effort should be kept in mind. The agreements allocate about three-quarters of the U.S. industry share of the FS-X R&D budget, or about \$825 million, to Lockheed Fort Worth.⁵ This amount also includes a one-time license fee of \$60 million for the F-16 TDP paid by MHI at the beginning of the program.⁶

Compared to the revenue and employment a major U.S. tactical fighter program would generate for its prime contractor, FS-X is a relatively minor effort. As a result of its purchase of GD's fighter division, Lockheed's share of the U.S. Air Force's F-22 fighter program rose to about 68 percent. With total F-22 R&D costs projected at around \$9.5 billion, Lockheed's share could amount to over \$6.6 billion, or about eight times the income from FS-X over

⁴According to American officials, U.S. industry's share stood at 46.4 percent of the R&D budget in August 1993. Letter to the author from the Weapons Division, DSAA, August 16, 1993. However, industry officials rightly point out that the final workshare percentage U.S. industry receives will only be known for certain once the R&D program is complete and the data are fully analyzed. Letter to the author from Lockheed Fort Worth, March 9, 1994.

⁵In early 1993, Lockheed purchased the General Dynamics (GD) Fort Worth fighter division, the original developer of the F-16. This division was renamed the Lockheed Fort Worth Company.

⁶The Japanese also agreed to pay a royalty fee of roughly \$500,000 for every production FS-X manufactured, which would result in another \$65 million or so for a production run of 130 aircraft (all numbers are in calendar year 1985 dollars).

approximately the same period of time.⁷ In 1992, GD Fort Worth officials expected the number of their employees working on the FS-X program to rise from about 400 in 1992 to around 1,000 in 1993.⁸ Yet this increased employment hardly compensated for the massive reductions that defense budget cuts caused in the work force at the Fort Worth plant. Indeed, between 1990 and 1992, GD Fort Worth laid off more than 10,000 employees in response to the Pentagon's cancellation of the Navy A-12 fighter-bomber R&D program and the decision to cut back F-16 production radically (Towle, 1992a).

Observers have rightly point out, however, that the FS-X program will provide about as much revenue and employment for the prime contractor as a licensed-production deal or even an off-the-shelf sale for the same number of aircraft. After 1994, employment and income at Lockheed's huge mile-long manufacturing facilities at Fort Worth will probably depend solely on F-16 foreign sales, licensed-production agreements, and the FS-X program. However, several other foreign deals will provide considerably more income and jobs than FS-X. For example, the sale of 150 F-16s to Taiwan, announced in mid-1992, will reportedly bring in \$6 billion and employ 3,000 Fort Worth workers over the life of the program (Towle, 1992b). Few concerns over technology transfer have been raised by this deal, since Taiwan will probably domestically manufacture at most about 10 percent by value of the aircraft's parts.⁹ Another program for licensed production of 120 F-16s in Korea is valued at around \$5 billion and will support 1,000 U.S. jobs at Fort Worth. The first 12 F-16s will be purchased off the shelf, followed by the assembly in Korea of 36 fighters from "knockdown" kits manufactured by Lockheed. A significant percentage of the parts used in the remaining 72 aircraft to be license-produced in Korea will still come from Fort Worth. Off-the-shelf sales to many other countries have also been won or are pending (Towle, 1992a).

Thus, while the FS-X program provides Lockheed with substantial income and employment, it is hardly the only foreign pro-

⁷Prior to the acquisition of GD's fighter division, Lockheed led the F-22 program with a 35-percent share, supported by Boeing and GD with 32.5 percent each. See Finnegan and Opall (1992).

⁸"Zero of the '90s" (1992).

⁹"Taiwanese Want F-16 Trade-Off" (1993), p. 5.

gram keeping the Fort Worth division in business. Furthermore, compared to major domestic programs, such as Lockheed's F-22, it is a relatively small-scale effort.

Flowback and Access to Japanese Technology

Since cooperative development of the FS-X carries the potential for enhancing the indigenous aerospace capabilities of Japan far more than foreign sales or licensed production, it is not surprising that, during the 1989 debates, FS-X supporters emphasized the benefits of gaining access to Japanese technology as compensation. However, after nearly four years of FS-X development, it still remains highly uncertain whether the U.S. government or industry will significantly benefit from the access rights to Japanese technology.

Making Use of Japanese Composite Wing Data. After many initial difficulties, the Japanese are transferring a substantial quantity of technical data on the CFC wing and other aspects of the aircraft. Lockheed is successfully moving ahead with the manufacture of one-third of the CFC wings for the R&D program. Yet initial indications suggest that the Japanese design, materials, and manufacturing philosophies for the wing and other composite structures may not be of great interest to the American military aerospace industry. As Lockheed's Vernon Lee told reporters early in 1993, the technologies associated with both the Japanese co-cured wing and APA radar are "not applicable" to either the new F-22 or possible future modifications of the F-16. He observed that, although the Japanese are supplying plenty of data, the U.S. side "might decide that you can't find an application" for the Japanese FS-X technology.¹⁰

Lee's assessment probably derives from several factors. The basic Japanese material technologies and design methodologies used on the FS-X airframe are generally not as advanced as those found in U.S. industry. Contrary to typical U.S. practice, the Japanese approach appears to emphasize manufacturing ease over performance and other military requirements. Furthermore, since the American contractors played at best a minor role in designing

¹⁰Quoted in "FSX Composite Data Will Be Too Late for Use on F-16 or F-22" (1993).

and developing the wing, it is difficult to determine the full rationale behind Japanese design decisions. Throughout most of the initial phases of the R&D program, neither the U.S. government nor industry provided sufficient funds to catalogue properly and to assess fully much of the other Japanese technical data being transferred, although this situation may be improving.

The invar tooling the Japanese use for the CFC wing aptly illustrates many of these points. In the view of some U.S. engineers involved in the program, the wing design has been driven overwhelmingly by unique Japanese manufacturing and testing objectives at the expense of traditional performance and weight considerations that dominate U.S. defense programs. The Japanese engineers insist that the most important technology is in the tooling, not the wing itself. Japanese industry has invested considerable time and money in developing the expensive and complex invar tooling and silicon bladder bags to hold the wing spars and ribs in place during the curing process. Indeed, some have characterized the wing R&D program as more of an effort aimed at prototyping the tooling and manufacturing process than the wing itself. But the Japanese approach mystifies some U.S. engineers. They argue that U.S. prime contractors would hesitate to use invar tooling routinely because it is difficult to modify when changes to the aircraft structural design are made and, most important, because it is so expensive.¹¹ Other U.S. engineers argue that, because of the strong Japanese emphasis on manufacturing and tooling, the wing may end up being heavier, more expensive, and less capable than a traditional aluminum wing.¹²

However, there are other American engineers involved in FS-X who believe the overall concept embodied in the Japanese approach has considerable merit. They strongly support the Japanese emphasis on the manufacturing process and prototyping tooling. In support of their position, they argue that a key problem with the ill-fated A-12 program and other U.S. efforts is the lack of an initial

¹¹The tooling U.S. prime contractors use for composite structures is typically made out of aluminum, composites, titanium, and other materials. GD subcontracted the manufacture of its invar tooling for the FS-X wings to a U.S. supplier that had been qualified by Boeing based on its previous experience working with the alloy.

¹²Interviews with GD engineers, FSET, Nagoya, June 15, 1992, and Fort Worth, August 4, 1992.

investment in tooling and process technology. They point to the very high quality and lack of faults in the Japanese-manufactured composite structures as an example of the results that can be obtained by adopting different practices more akin to those used by the Japanese. They point out that the Japanese approach to developing tooling and the use of invar may provide important lessons for American companies. Indeed, Lockheed is already using invar tooling for the F-22 program, and Boeing uses the same material for tooling on other programs.¹³

Yet, at least through the end of 1992, even the supporters of the Japanese approach would still have generally agreed with one U.S. engineer, who claimed "the Japanese technology probably won't ever be used," if for no other reason than that the U.S. government and industry were not committing the necessary resources to evaluate it thoroughly.¹⁴ Up until this point, most of the U.S. views on Japanese technology were based largely on inference and speculation. Since the American engineers were not extensively involved in the basic design and development decisions, no one on the U.S. side really knew the detailed rationale, design philosophy, and methodology behind the Japanese approach.

According to U.S. engineers at that time, a systematic assessment of Japanese cocured wing technology would require at least two components. The first would evaluate the Japanese design philosophy and approach used on the wing in terms of the priorities and methodologies established by the U.S. military services, focusing on such factors as cost, weight, and performance. The second would evaluate the tooling and manufacturing technology employed by the Japanese and would assess its applicability to the U.S. industrial environment. Yet, prior to 1993, neither of these types of assessments was being done systematically. The primary reason was that neither the U.S. government nor industry was willing to devote the considerable financial and personnel resources necessary to carry out such efforts. Some observers suspected the necessary motivation was lacking because many technical experts still doubted the Japanese approach would prove in the end to be cost-effective or technologically superior.

¹³Interviews with GD engineers, FSET, Nagoya, June 15, 1992, and Fort Worth, August 4, 1992.

¹⁴Interview with a GD engineer, Fort Worth, August 4, 1992.

Nonetheless, at the end of 1992, U.S. industry began greatly increasing its efforts to assess Japanese wing technology and the huge amount of derived data transferred by the Japanese. This effort, if successfully and fully carried out, may yet identify significant new areas of technological interest to U.S. industry as the development program progresses.

Derived Data. In the early phases of the R&D program, many of the same observations discussed above applied equally to the assessment of derived technology not directly associated with the wing. Since 1991, the Japanese prime contractors have been supplying a considerable amount of data and documentation on aspects of the airframe and subsystems other than the wing that are treated as derived technology. By mid-1992, GD engineers had identified several areas of possible interest, including the composite skins KHI had developed for the center fuselage, hardware components used in the flight-control system, the Japanese design for the larger horizontal tail plane, and other areas.¹⁵ Yet, through 1992, only two or three engineers were routinely engaged in reviewing the thousands of data items coming in from the Japanese firms. In the early phases of the R&D effort, GD expended little time or money on trying to identify interesting technology areas and aggressively seeking additional data on those areas; as a result, GD had no way to assess the completeness of the data being transferred. In essence, the American company was just passively accepting what the Japanese chose to send.

At one point early in the R&D effort, GD officials roughly calculated what resources would be necessary to carry out a more thorough but still preliminary assessment of the content and completeness of incoming Japanese data. They concluded that such an effort would require about 20 full-time employees, mostly engineers, at a cost of around \$4 million a year. However, with the FS-X budget under great pressure and the problems with program cost, neither GD managers nor working-level Air Force officials could identify where the money and personnel to support such an effort could be found.

A serious attempt to rectify many of these problems associated with both the wing technology and derived technology appears to have gotten under way at the end of 1992. In December, senior GD

¹⁵Interview with a GD engineer, Fort Worth, August 4, 1992.

officials met with high-level government representatives in Washington who urged a more aggressive effort to identify and pursue Japanese derived and wing-related technology. In particular, officials increasingly recognized that U.S. industry had to acquire the Japanese background data on design methodologies, analysis techniques, and manufacturing processes related to the composite wing if the technology was to be effectively transferred and assessed. As a result of this meeting, GD officials increased their efforts in these areas. Engineers began preparing lists of the types of data the Japanese should have generated in the process of developing the wing. A typical example would be the process by which the Japanese engineers decided on what type of silicon rubber to use for the inflatable bags that reinforce the internal wing structure during the curing process. GD also began examining possible sources of funding to assess independently how best to exploit Japanese technologies and techniques for possible applications to other programs. For example, JDA did not impose a detailed technical specification on the wing for a specific level of resistance to ballistic (battle) damage. Under the new proposed assessment plan, GD might evaluate how a typical U.S. Air Force requirement on ballistic damage would affect the design, materials, and manufacture of the wing.¹⁶

Under its new Lockheed management, the Fort Worth fighter division continued to improve its capabilities to process and evaluate Japanese derived and wing data throughout 1993. A second librarian was added to assist in writing abstracts of the thousands of incoming technical documents. This effort considerably reduced the backlog that had built up over the previous months. By October 1993, Fort Worth had received about 13,000 data items, of which approximately 7,000 were actual documents. (The remainder were composed of drawings, photographs, tapes, and so forth.) At that time, about 80 percent of the documents had been abstracted and catalogued, and all data items were being recorded on a computerized filing system. And perhaps most important, management formed a technical working group of about ten engineers to assess the cured wing box and its associated technology. Some funds had also apparently been made available for initial evalua-

¹⁶Interview with a GD engineer, December 21, 1992.

tions of other technologies and data coming in from Japanese industry.¹⁷

Thus, beginning in late 1992, significant improvements began to be made at Fort Worth in processing and assessing the massive data inflow from Japan. By the end of 1993, however, it still was not entirely clear whether the level of effort necessary to evaluate the data fully had yet been achieved, although the establishment of the wing box working group appeared to indicate a major initiative in that technology area. Even less clear was whether such assessments would ultimately uncover any Japanese wing or derived technologies of overriding interest to Lockheed or other American prime contractors. Indeed, a consensus among U.S. industry experts had clearly begun to emerge that discounted the importance of any new specific Japanese technologies. According to this view, the impressive ability of Japanese industry to manufacture high-quality large cocured structures resulted primarily from Japanese management techniques, special attention to tooling, and a highly skilled and well-motivated work force. Undoubtedly, the U.S. aerospace industry could benefit from adopting some aspects of the Japanese management and tooling development philosophies. However, there appeared to be few really new or unique specific technologies the Japanese could transfer to American companies.¹⁸ Indeed, as recently as January 1995, public statements by U.S. industry officials seemed to indicate that the U.S. assessment of the limited value of Japanese technology had not changed. For example, Vernon Lee of LFWC pointed out that Japan's cocured composite wing technology is unique, but not "better" than what has been developed by U.S. industry. Although he called transfer of the cocured composite technology "one of the success stories of the program," he added that "Just because you've got the technology doesn't mean you need it." (Mecham, 1995.)

Nonetheless, it will not be possible to arrive at any definitive conclusions about the ultimate utility and applicability of Japanese technology until FS-X development is complete. Without doubt, Lockheed is already gaining benefits, in addition to the basic con-

¹⁷Interview with a Lockheed Fort Worth official, October 25, 1993.

¹⁸A more detailed discussion of FS-X wing technology and its potential value to U.S. industry can be found in Brown (1993).

tract fees from the program, that it believes are significant. As one official explained,

Lockheed has used this opportunity to develop new management techniques for technology development, bring new business management systems on line, and advance the state of the art in Software Test Stations and software development capabilities as well as that of electronic "mock-ups."¹⁹

What is certain is that the Japanese appear to have largely kept their side of the bargain by transferring significant quantities of data; whether the U.S. side will fully assess the technology, or find any of it of great value, remains to be seen.

The Four Japanese Nonderived Avionics Systems. With respect to the four nonderived Japanese avionics systems, American officials continue to make slow but steady progress at gaining access to additional data. By the fall of 1993, U.S. Air Force radar experts at Wright-Patterson Air Force Base were well along in testing various performance parameters of the five MELCO T/R modules purchased earlier in the year. Technicians planned to complete their tests and report the final results to JDA and TRDI in early 1994. After appropriate discussions with the Japanese, the U.S. side hoped to generate a written report on the test results, a version of which could be distributed to interested U.S. industry officials. However, none of these tests directly address the issues of production costs and manufacturing processes, the areas originally identified as most important from the American perspective. Although the U.S. government purchased some additional data related to production costs and technology when it acquired the T/R modules, the data apply only to the modules produced for the prototype engineering-model radars, which were not manufactured with fully automated processes.²⁰

No further contacts between U.S. and Japanese companies were reported in the press during the year following the Westinghouse and Hughes meetings with MELCO in October 1992. However, U.S. government teams continued to visit Japanese companies to examine various aspects of the APA radar and the other

¹⁹Letter to the author from Lockheed Fort Worth, March 9, 1994.

²⁰Interview with a U.S. Air Force officer, Nagoya, October 26, 1993.

avionics systems throughout 1993. In 1994, officials hoped to include industry representatives in further visits.²¹ Nonetheless, the Japanese avionics systems still appear to be generally lower performance than comparable U.S. systems. Usable data on manufacturing costs and processes remain difficult to acquire. Much of the basic manufacturing technology the Japanese use seems to differ little from the U.S. approach. If the Japanese can achieve significant cost savings in the manufacture of T/R modules or other components used in the nonderived avionics systems—which has not yet been clearly demonstrated—it may be due to the unique structure, management philosophy, and organization of Japanese industry that permits spin-on of manufacturing techniques from the commercial sector. These factors may be difficult to transfer to the U.S. defense industry, because of its dramatically different structure (see Chang, 1994).

A TECHNOLOGY TRANSFER DRAW?

In the final analysis, the whole debate over the two-way transfer of technology on the FS-X program may prove to be largely irrelevant. The fears expressed by FS-X opponents that the United States had agreed to give away some of its most advanced aerospace technology to Japan appear overblown. Technology transfer to Japan has been carefully controlled and heavily restricted. Japanese industry will gain little that it has not already acquired from previous programs. More technology and skills with direct commercial applications may be acquired by Japanese industry through collaboration with Boeing on the B.777 airliner development program than on FS-X (see Mecham, 1995).

At the same time, many of the claims about the potential value of Japanese technology that may be transferred to U.S. industry during the program may also turn out to have been exaggerated. After the first few years of R&D, it still did not appear likely to most observers that U.S. industry would acquire any technology of great significance during the program, although this assessment could change as R&D progresses.

²¹See "Commerce Plans FS-X Technology Evaluation Visits for Industry Next Year" (1993).

In this sense, then, the program may end up as a technology-transfer draw, with neither side gaining significant new technology from the other. But this is hardly the most important technological aspect of the FS-X program for either side.

MILITARY R&D: LONG-TERM BENEFITS FOR JAPAN

The primary benefit of the FS-X program for Japanese industry is not coming through the transfer of F-16 related technology—although this has certainly provided many benefits—but rather from the structure of the program, which allows Japan to pursue a broad spectrum of national technological objectives originally sought through indigenous development of a national fighter. It is here that the real technological and political significance of the program lies.

Following the Japanese selection of the F-16/SX-3 design in October 1987 as the baseline for the cooperative development of the FS-X, a prominent Japanese aerospace observer predicted that “in the end, 80% of [the FS-X] will be Japanese.”²² Concerned U.S. observers at the time agreed. According to one, “it looks like it will have an F-16 logo on it But if they modify it as much as they plan, the only thing they haven’t modified is the name.”²³ Several days later, the widely respected industry journal *Aerospace Daily* reported that the planned modifications to the baseline F-16 “are so extensive as to constitute virtually a new aircraft.”²⁴

Four and a half years later, TRDI’s Lt Gen Kiyoshi Matsumiya stood in front of a full-scale wooden mock-up of the FS-X fighter at its public unveiling at MHI’s Komaki South plant in Nagoya, not far from where Mitsubishi had built the infamous Zero-Sen fighter a half-century earlier. General Matsumiya announced to the assembled crowd of reporters and honored guests: “This will be the Zero fighter of the modern era.”²⁵

²²Quoted in Lachica (1987b).

²³Quoted in Lachica (1987b).

²⁴“Japanese Reveal Details of F-16 Conversion to FSX Requirements” (1987).

²⁵Quoted in “Zero of the ‘90s” (1992). At least one U.S. program official believes General Matsumiya’s remarks have been misinterpreted in the United States. According to this official, the Japanese general was not referring to the

It is not possible to predict whether the FS-X will ultimately achieve the same fame and notoriety that Mitsubishi's Zero fighter won during World War II. What is far more certain, however, is that, at least in Japanese industry circles, FS-X will be viewed as the first largely all-Japanese-developed world-class fighter aircraft since World War II. Although such a view is perhaps a bit exaggerated, it is not without merit.

The Enduring Pentagon Goal: Stopping Indigenous Development

As noted many times throughout this book, the evolution of the FS-X in the direction of a largely Japanese-designed and -developed fighter, extensively equipped with Japanese systems and major components, profoundly contradicts many of the most basic objectives advanced by senior Pentagon officials at the beginning of negotiations for a cooperative program. Richard Armitage, the former Reagan administration Assistant Secretary of Defense, later recalled that he, Secretary Weinberger, and the other high-level Pentagon leadership had been "appalled" when they learned in 1985 that Japan planned to indigenously develop the FS-X fighter.²⁶ He explained that he and other senior DoD officials opposed indigenous development primarily because of strategic military and foreign-policy considerations. Indigenous development might further loosen the bonds of the U.S.-Japan security relationship and contribute to the emergence of a Japanese security policy less amenable to U.S. influence. DoD and Department of State officials had also expressed concern about the long-term effects on regional stability of a growing Japanese national capability to develop advanced weapon systems, such as fighter aircraft, independently. They worried particularly about the possible reactions of China and South Korea, countries that still har-

evolution of the FS-X into a Japanese-developed fighter, but rather noting that, like the Zero before it, the FS-X would be a world-class fighter. Letter to the author from a U.S. Air Force official, January 28, 1994.

²⁶Statement at the U.S./Japan Economic Agenda's *Conference on High Technology Policy-Making in Japan and the United States: Case Studies of the HDTV and FSX Controversies*, Georgetown University, Washington, D.C., June 8, 1993.

bored suspicions about latent Japanese militarism dating back to their experiences during World War II.

During the 1989 FS-X hearings before Congress, senior Bush administration officials from the DoD and the Department of State revisited these same themes. At that time, Secretary of Defense Dick Cheney testified to the House that a rejection of the cooperative FS-X agreement would permit Japan to return to its original objective of indigenous development. "The most damaging impact" of such a turn of events, he continued, "would be on the [U.S.-Japan] relationship as a whole, with Japan pursuing increasingly independent security policies." (House 1989c, p. 62.) He argued that Japan had finally accepted cooperative development of the FS-X to reduce costs and promote interoperability with U.S. equipment and because of "the potentially adverse effect that unilateral development could have on Japan's long-term defense relationship with the U.S." (House, 1989c, p. 57.) Carl Ford, the Deputy Assistant Secretary of Defense and the coauthor of the final report of the FS-X interagency review, expanded on the same themes in other hearings. He emphasized that "DoD did *not* enter into the FSX agreement for the purpose of seeking technology from Japan" or for other economic or industrial objectives. Rather, the Pentagon sought a cooperative program primarily because of "the real possibility of Japan going it alone in the military aerospace industry, and eventually with its security policy." Having built an indigenous military aerospace capability, Ford continued, a "plausible alternative security and foreign policy direction for Japan would be to follow a more nationalistic course."²⁷

The growing Pentagon focus on increasing defense burden-sharing among America's allies also led DoD officials to oppose indigenous development. Greater burden-sharing meant Japan needed to contribute more in the areas of mission responsibilities, force structure, and host-nation support for U.S. regional forces. With Japan spending relatively modest amounts on defense in proportion to its gross national product, Pentagon officials constantly pressed JDA to seek maximum military effectiveness from its limited funds available for equipment procurement. In this context, indigenous development seemed like a waste of scarce procurement

²⁷Ford quotations from House (1989a), pp. 213, 218, 219-220. Emphasis in the original.

resources. Typical were the comments of Richard Perle, a former Assistant Secretary of Defense, who told Congress during the FS-X hearings that "it drains away from the Japanese defense budget . . . funds that are vitally needed for the common defense." (House, 1990b, p. 59.)

DoD officials believed the unit cost of an indigenously developed Japanese fighter would rise to several times that of a comparable U.S. fighter purchased off the shelf or license-produced. In addition, the more expensive indigenous fighter would in all likelihood be less capable than an existing U.S. fighter, for two reasons. First, American experts believed Japanese industry did not possess the technological expertise and experience to develop a fighter equivalent to existing U.S. aircraft. Second, the U.S. side was convinced that JDA and the ASDF lacked the necessary knowledge and experience to generate sensible military requirements to guide development of the fighter. As the end result of indigenous development, the ASDF would be forced to procure fewer of the more expensive, lower-performance national fighters, leading to a far less capable overall force structure. Furthermore, ASDF procurement of a Japanese-designed fighter equipped with domestic subsystems would probably reduce interoperability between Japanese and American equipment, thus further undermining the military effectiveness of combined operations conducted by the two allies.

Some DoD officials were also beginning to express concern about the long-term prospects for maintaining the health of the U.S. defense industrial base in an increasingly competitive global environment. U.S. military procurement budgets began declining in real terms in the mid-1980s, as military R&D and procurement costs continued to skyrocket. At the same time, the global market appeared to be contracting, as new competitors continually sought to enter the field. With no more than two major new fighter R&D projects likely to be funded throughout the remainder of the century, Pentagon officials increasingly viewed sales to allies and shared modification programs as ways to help maintain the U.S. defense industrial base.

Pentagon officials did not single out Japan in its quest to block indigenous fighter development. Using virtually the same arguments as those mustered against an all-Japanese FS-X, DoD fought hard to convince other close allies to drop national fighter-

development programs throughout the 1980s. After a long and acrimonious battle with the Israelis, U.S. pressure finally helped bring about cancellation of the Lavi fighter program in August 1987. Several times during the decade, DoD launched major efforts to convince the Europeans to drop development of the EFA and Rafale fighters and replace them with existing or modified versions of U.S. fighters.

It is true, however, that both Japan and Germany, the two main Axis powers of World War II, have been treated somewhat differently than America's other postwar allies in the area of military aerospace procurement. The original decision to permit rearmament of both countries in the mid-1950s was highly controversial. Since then, a variety of political and economic constraints were imposed by the United States and other allies to discourage the development of full-spectrum military aerospace industries in both countries. In the case of Germany, this was achieved through military and economic integration within NATO and the European Community. Interestingly, since the end of World War II, Germany has never developed any type of major military aircraft on a purely national basis. In stark contrast to the situations in Great Britain, France, Italy, Sweden, and even Spain, not a single combat fighter, attack aircraft, large military transport, or advanced jet trainer has been developed indigenously by German industry and gone into production since World War II.²⁸ Compared to Germany,

²⁸In the 1950s, the Luftwaffe flew off-the-shelf U.S. fighters. German industry also license-produced the French Fouga Magister jet trainer and Nord Noratlas tactical transport. In addition, the Luftwaffe procured the Fiat G.91 fighter, a light attack aircraft patterned after the North American F-86 and developed by Italian industry. In the 1960s, German industry license-produced the Lockheed F-104G fighter/attack aircraft. The German armed services also procured the Transall C.160 tactical transport and the Atlantic antisubmarine patrol aircraft, developed collaboratively with France and other European countries. Late in the decade, German firms joined British and Italian companies in the cooperative development of the Panavia Tornado strike/attack aircraft and also linked up with a French company to develop the Alpha Jet trainer. In addition, the Luftwaffe bought versions of the McDonnell-Douglas F-4 Phantom. In the mid-1980s, German industry began development of the EFA in collaboration with Great Britain, Italy, and Spain. German companies never held the position of lead contractor or won the overall design lead on any of these collaborative military aircraft programs.

In the late 1950s and early 1960s, German industry developed flying prototypes of a fighter, attack aircraft, and military transport, all with vertical take-off and landing capabilities. None of these aircraft, however, entered into production or even completed development.

then, Japanese industry has done quite well with the indigenous development of the F-1 support fighter; the T-1, T-2, and T-4 jet trainers; and the C-1 jet tactical transport, as well as numerous tactical combat missiles and other air weapons.

Pentagon Goals for Cooperative Development of the FS-X

Thus, for a variety of military, political, and industrial-base reasons, stopping an indigenous development program remained the fundamental U.S. objective during the negotiations over FS-X from 1985 through 1987. Pentagon and Department of State officials repeatedly emphasized that purchase or licensed production of an existing U.S. fighter was the preferred solution. Such solutions would contribute little to the enhancement of Japanese capabilities to design and develop an indigenous fighter in the future, provide the most cost-effective improvement in Japan's self-defense capabilities, and maximize interoperability with U.S. equipment. But the U.S. side concluded early on that, short of a major diplomatic confrontation, Japan could not be persuaded to accept such solutions. The political power of the *kokusanka* supporters appeared more than sufficient to block government acceptance of an off-the-shelf purchase or licensed production. As the next best approach, the Pentagon settled on the option of cooperative development of a modified U.S. fighter and spent over two years of negotiations trying to convince Japan to accept it.

The initial U.S. assumptions behind the promotion of a cooperative modification program included that (1) DoD and American industry would exercise considerable, if not decisive, influence over the design and development of the aircraft; (2) the modifications of the U.S. fighter would be relatively modest and low-cost compared to a wholly new development; and (3) such a program would contribute only marginally to improving Japanese industry's overall capability to develop an indigenous fighter. Many DoD and industry officials also sought to achieve even greater burden-sharing benefits by formulating a cooperative program that would directly contribute to meeting future procurement requirements of one of the U.S. services, as well as other allies. No one advocated helping the Japanese undertake a unique national modification of a U.S. fighter solely for use by the ASDF, unless the modifications were

minor. Rather, Pentagon officials hoped to settle on a design and configuration that could have broader application.

Not surprisingly, then, all the modification proposals presented to the Japanese in 1986 and 1987 represented designs that had been developed in consultation with the U.S. Air Force and Navy and that were also aimed at the European market. GD's SX-1 was only a slightly modified F-16, while the big-wing SX-2 and SX-3 were directly patterned after the Agile Falcon proposals targeted at the U.S. Air Force and NATO allies in Europe. With encouragement from the Pentagon, GD withdrew its much more radically modified two-engine SX-4 proposal soon after offering it to the Japanese. The SX-4 was of no interest to the U.S. Air Force or the Europeans. It would require such extensive modification of the F-16 that it would essentially represent a new aircraft, thus negating all the Pentagon goals for a collaborative program with Japan. In a like manner, McDonnell-Douglas's Super Hornet proposals based on the F-18 had been developed with an eye to the U.S. Navy's future upgrade requirements and as tempting alternatives to the costly EFA and Rafale programs. All U.S. contractor proposals initially assumed the use of American systems and components throughout the aircraft.

As the negotiations continued into 1987, the American firms made increasing provisions for incorporating Japanese technologies and performance requirements into their design proposals. Prominent among these were the four major Japanese avionics systems, CCV canards, and other changes. McDonnell-Douglas's final offerings included the Super Hornet Plus, which boasted an all-new wing design. But U.S. officials seem to have believed that, even if the Japanese chose one of the more ambitious modification proposals, American industry and the Pentagon would be able to exercise considerable influence over the detailed design, development, and technological content of the program. Furthermore, it was thought that a Super Hornet modification might be adopted by the U.S. Navy or sold to the Europeans in place of EFA or Rafale. Indeed, once the Sullivan team concluded in the spring of 1987 that Japanese fighter technology developments were less advanced than previously thought, some U.S. officials argued that selection of a radical modification proposal, such as the Super Hornet Plus, would make the Japanese even more dependent on U.S. industry and enhance U.S. control over the program. Whatever design was

chosen, most Pentagon officials believed cooperative development would dramatically reduce the overall R&D experience Japanese industry would gain compared to the development of an indigenous fighter and would tie Japanese companies in closer with their American counterparts.

During the interagency review in early 1989, U.S. officials attempted to place even greater constraints on the ability of Japanese industry to conduct significant new R&D within the framework of a cooperative FS-X program. At that time, both the DoD and DoC formally agreed as a matter of basic policy to seek maximum commonality in design and subcomponents between the baseline F-16 design and the FS-X. While this policy was advocated primarily for industrial and technological reasons in 1989, DoD officials had of course sought maximum interoperability and equipment commonality through collaboration with Japan and other allies since the 1970s. The interagency review served to confirm this policy explicitly about the FS-X.

As one significant benefit of the program, some senior U.S. officials believed that basing the FS-X on the F-16 would prevent Japanese industry from developing the capabilities to develop an advanced air superiority fighter indigenously to replace the F-15 after the turn of the century. As James Auer argued in June 1989 during a public defense of the recently "clarified" FS-X deal,

Now their chance of building the next air-to-air fighter on their own becomes close to zero because they simply will not have the expertise and experience of doing this on their own. I think [the FS-X deal] holds them at least two generations [of fighter aircraft development] away, which I think obviously is very much in our own selfish interest, but I think it's very much in Japan's political interest as well.²⁹

An Extensive Modification Program Approaching Indigenous Development

Yet after nearly four years of actual R&D, the reality of the FS-X development program appears to have shifted significantly away from the original DoD conception. In outward appearance,

²⁹Lecture by James Auer, University of Southern California, June 22, 1989.

the FS-X still closely resembles the F-16, as shown in Figure 12.1, as did many design elements of the Lavi prototypes that Israel indigenously developed. Some observers concluded that this “represents a kind of victory for the U.S. government.”³⁰ But appearances can be deceptive. The FS-X airframe does not just represent a standard F-16 with the simple addition of a 16-inch fuselage plug extension, a new canopy and radome, and the GD-designed Agile Falcon wing, as it was sometimes characterized when Japan first agreed to a cooperative program. As Brig Gen Robert Eaglet pointed out at the end of 1990, over 95 percent of F-16 engineering drawings are being changed for the FS-X. Mitsubishi has essentially used the existing F-16 design as a reference guide and starting point for its own extensive design

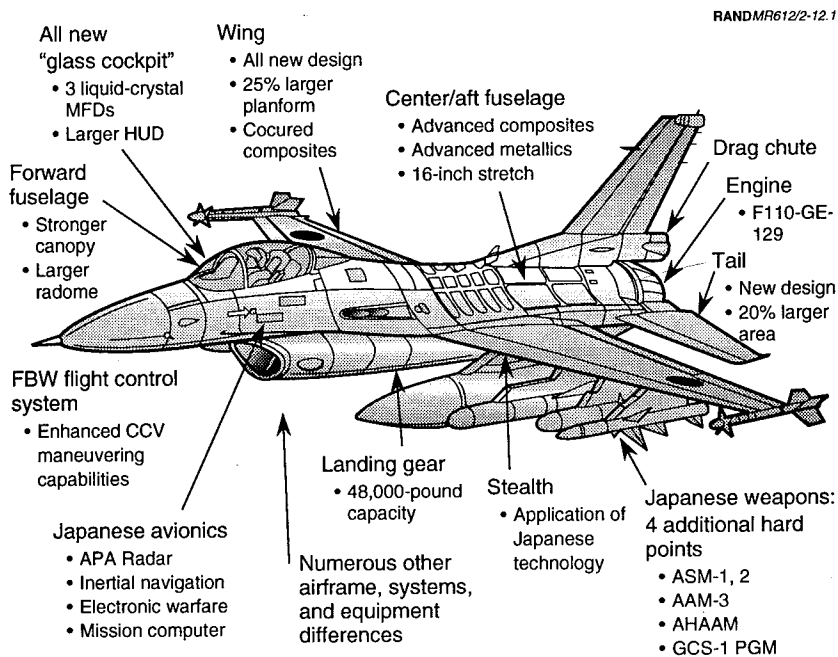


Figure 12.1—Major Differences Between the F-16 and the FS-X, 1993

³⁰“Zero of the ‘90s” (1992).

excursions that go far beyond the routine engineering changes normally associated with typical modification programs.

The ultimate irony is that the FS-X deal forced on Japan in 1987 probably ended up in many ways representing a better deal from the perspective of Japanese industry than a purely indigenous development would have. Instead of starting from scratch with a totally new and untested design, Japanese engineers can use F-16 technical data and thus adopt a more incremental and lower-risk approach of experimenting with interesting variations on a proven baseline design. The program thus provides Japanese industry a lower-risk approach to honing its design and integration skills, while providing plenty of flexibility for the further development and application of its indigenous technologies and subsystems.³¹

The FS-X wing planform design and internal structure illustrate this point. The wing generally resembles the 375-ft² enlarged-wing design GD originally developed for its early Agile Falcon proposals. However, the FS-X wing actually represents an all-new design that Japanese engineers developed with little direct GD input. The data Japan received on the original SX-3/Agile Falcon wing were rudimentary at best. Although GD expected to take part in the actual wing design, Japanese engineers designed the wing independently, outside of the joint FSET organization at Nagoya. GD sent several aerodynamic engineers to the FSET to work on the wing, but the Japanese never used their services. The resulting wing design is different from any of the original GD wing proposals based on Agile Falcon designs. It varies in aspect ratio, thickness ratios, detailed planform shape, and other parameters. One GD official characterized it as more like an enlarged Northrop F-5 wing than an Agile Falcon wing.³² The FS-X wing varies even more dramatically in its internal engineering and structure. Here, the Japanese designers used an entirely different approach and strength philosophy than GD engineers are accustomed to in plac-

³¹Chinworth and others make this same argument. See Chinworth (1992), pp. 158-160. On the other hand, some observers have also rightly noted that basing the FS-X on the F-16 gives the Japanese less experience in the "front end" aspects of system engineering than would a fully indigenous development program, in which engineers carry out the transition from operational requirements to performance requirements for individual configuration items.

³²A technical discussion of the unique FS-X wing design and fuselage structure can be found in Aoki (1993b).

ing the spars and other internal support structures. The wing will also have stealth features through the extensive application of Japanese-developed radar-absorbing materials to the leading edges and elsewhere (Aoki, 1993b; Ebata, 1993, p. 462).

The situation with the wing applies in varying degrees to much of the rest of the airframe. Like the main wing, the horizontal stabilizer has also been enlarged and completely redesigned. It is about 20 percent larger and has a different shape and aspect ratio from those of the F-16's tail plane. The vertical stabilizer is identical to that of the F-16 but incorporates a new housing for a drag chute. Unlike the F-16, the FS-X's fuselage and tail structure will make extensive use of composite materials and new alloys. Although a side view of the FS-X's fuselage closely resembles the F-16's in general shape, numerous changes in design and materials have been made, some of them significant. The nose radome, for example, is a different size and shape to fit the specifications of the MELCO APA radar, and the cockpit canopy is a new design. The fuselage has been stretched 16 in. but retains the basic F-16 cross section. Aft-fuselage speed brakes, small nose air intakes, and new access doors have been added. Other minor design changes have been made to accommodate the new engine. CFCs will be used for the landing-gear doors, as well as for the skins covering the front part of the center fuselage and the vertical and horizontal stabilizers. New metal alloys will be applied to the wing-root fittings in the fuselage, as well as in many other places in the aircraft structure. The only large traditional metal structure similar to the F-16 will be the aft fuselage that Lockheed Fort Worth developed and produced.³³

These extensive design changes have been carried out almost entirely by Japanese engineers. MHI exercises nearly complete design and technical control over the FS-X R&D program. The Japanese firm makes all the key design and engineering decisions with little American participation. Indeed, Japanese engineers conducted most of the aerodynamic design work off-site from the FSET. MHI is also conducting virtually all the airframe and avionics integration work on its own in concert with the other Japanese contractors.

³³A detailed technical comparison of the FS-X to the F-16 can be found in Sonoo (1992). Also see Ebata (1993), pp. 461-462.

In a like manner, the major subsystems and components incorporated into the FS-X are increasingly based on Japanese indigenous technology or Japanese-developed modifications of U.S. items. This trend was probably reinforced by the U.S. rejection of most of Japan's requests for licensed-production rights on 122 subsystems and components in 1991. The FS-X will have an entirely new "glass" cockpit instrumentation system, designed around three large multifunction displays incorporating color liquid crystal technology, and a new wide-angle HUD (Ebata, 1993, p. 462). And, of course, from the early stages of the program, the four most important and complex avionics systems in the fighter—the fire-control radar, the IRS, the mission computer, and the EW system—have been indigenous developments. In addition, the flight-control computer, the flight-control laws, and the associated computer software are all essentially being developed and integrated by the Japanese.

One could debate the proper characterization of the FS-X as either an extensively modified F-16 or an essentially new fighter. The point at which the accumulation of design changes and the incorporation of new technology and subsystems effectively transform a modified fighter into a new fighter is a question of interpretation and judgment. What is clear in the case of the FS-X is that the modifications and incorporation of new technology are extensive and that Japanese industry is in charge of the process.

Few would dispute the characterization of the Swedish Gripen and the Israeli Lavi as essentially indigenous fighters. In both cases, domestic firms led the design, development, and integration of their own fighters, as Japanese industry is doing on the FS-X. The Swedish fighter is based on a totally new design, while the Lavi fuselage—like the FS-X—resembles the F-16 with canards and a new wing attached. Also similar to the FS-X, the Lavi and Gripen use American engines. However, unlike the Japanese, both the Swedes and Israelis subcontracted the detailed design and development of the wings to foreign companies.³⁴ These two countries also contracted to the same U.S. firm to write their flight-control computer software.³⁵ The Israeli and Swedish fighters

³⁴Grumman for the Lavi, and British Aerospace for the Gripen.

³⁵The company, Lear-Siegler in Santa Monica, California, was later bought by a British firm and changed to Lear Astronics.

make extensive use of U.S. subsystems and components, as well as major avionics systems for the Gripen.

In contrast, the Japanese have designed and engineered their own wing and center fuselage, using the F-16 data as a baseline. They are developing their own material systems, tooling, and design philosophy for the wing, tail section, and center fuselage. They are developing and integrating all the most important avionics systems. They have indigenously developed their own flight-control laws and are writing their own software. They are introducing at least five Japanese-developed CCV maneuvering capabilities to the flight-control system and control surfaces, even though the vertical canards have been dropped. Increasing numbers of subsystems and components are of domestic origin or are based on modified U.S. technology. Japanese companies are incorporating an advanced "glass cockpit" into the FS-X using sophisticated liquid-crystal displays and other impressive technologies. Domestic stealth technology is being applied to the new fighter. Japanese industry is indigenously developing a full panoply of advanced munitions for use on the FS-X.³⁶ Given these comparisons, General Matsumiya's claim that the FS-X "will be the Zero fighter of the modern era" is certainly understandable, as is the view allegedly widely held at MHI that "the FS-X is not a revamped F-16 but rather a new fighter plane." And this view is not limited to the Japanese side. According to a knowledgeable U.S. industry expert intimately involved with the R&D effort,

[F]rom the Japanese perspective, the FS-X development program has been cost-effective for them. *They essentially developed an indigenous fighter for approximately \$3 billion—quite a deal, all things considered.*³⁷

A significant difference between the FS-X and other foreign fighter programs is the quality of some of the indigenous systems and technologies being incorporated into the new fighters. The

³⁶These munitions include a new antiship missile, the XASM; a semiactive air-to-air missile similar to the U.S. AMRAAM, designated the AAM-3; and an infrared-imaging guidance kit for attachment to "dumb" bombs, the GCS-1.

³⁷Letter to the author, 1994. Emphasis added. Other recent foreign fighter R&D programs, such as EF-2000 and Rafale, are running at \$8 to 10 billion or more.

most dramatic example about which we have some knowledge is the MELCO APA radar, the core system determining in large degree the future combat effectiveness of the FS-X. The MELCO radar exhibits performance capabilities roughly on a par with existing conventional radars developed by the United States for the F-16. Other existing U.S. fire-control radars based on conventional technology can actually outperform the current FS-X radar. The Westinghouse/Texas Instruments APA radar under development for the new Lockheed F-22 is expected to exceed nearly all of the MELCO system's performance characteristics dramatically.

Nonetheless, many U.S. experts concede that the Japanese radar represents a significant, if not unprecedented, achievement. No other fighter radar currently under development anywhere else in the world, including those for the sophisticated European EF-2000 or the French Rafale fighters, will incorporate APA technology.³⁸ More important, U.S. experts believe the FS-X system demonstrates that the Japanese have already mastered the basic technological and engineering challenges APA radar development poses. With this knowledge and experience in hand, Japanese industry could relatively easily scale up the performance capabilities of upgrades or future APA radars to a more impressive level. Similar characterizations may also apply to some of the other indigenous systems, subsystems, and components Japanese firms are developing—particularly avionics—but it is too early to make a definitive judgment. Few American observers believe the technologies and subsystems under development for the new European fighters—with possibly one or two exceptions—pose a serious long-term competitive threat to U.S. industry's leadership in military aerospace technologies. It may be unwise to make the same assumption about Japan's FS-X.

In a 1992 study of the Japanese defense industry, a prominent U.S. academic concluded that FS-X not only will provide the ASDF

³⁸The French hope to develop successfully a passive phased-array fire-control radar for the Rafale called the RBE-2. In May 1991, Thomson-CSF of France and GEC of the United Kingdom announced an agreement for the joint development of an APA antenna based on GaAs technology for use on a future APA radar. The two companies anticipated that radar development could be completed by 2005, about a decade after MELCO's APA radar is scheduled to fly in the first FS-X prototypes. However, at the time of the announcement of the joint European R&D effort, neither company possessed any capability for manufacturing GaAs integrated circuits. See de Briganti (1991).

with "its indigenous aircraft to show the rest of the world" but also "will bolster industry's confidence and will help sustain pressures for national development of next-generation aircraft regardless of military needs." (Chinworth, 1992, p. 160.) Despite the end of the Cold War, continued downward pressure on the defense budget, and significant FS-X cost growth, TRDI included funding in its fiscal year 1991 and 1992 budgets for R&D on advanced technologies and subsystems for future fighters. Prominent among these were technology programs applicable to future fighter turbofan engines, the main area of weakness in Japan's aerospace industry (see Asao, 1992). JDA planners also launched studies on future fighter replacement needs. The most immediate concern was the requirement to replace the aging fleet of license-produced F-4EJs after 2000. Options under study included upgraded versions of either the FS-X or the F-15J (Sekigawa, 1993b). TRDI was reportedly pushing for further R&D spending to support extensive upgrades to the FS-X. Sometime early in the next century, the ASDF's top-of-the-line F-15Js will also have to be replaced.

Indeed, by late 1994, various press accounts had revealed that TRDI was requesting an initial ¥1 billion for FY1996 to launch development of an all-new Japanese advanced stealth fighter, called the FI-X or FD-X. A prototype technology demonstrator is envisioned to fly in 2007. Reportedly, JDA kicked off the development effort by allocating funds to IHI in the FY1995 defense budget to begin R&D on Japan's first fighter turbofan jet engine, intended for the FI-X. The new Japanese fighter would incorporate cutting-edge technology and subsystems, such as a conformal radar, thrust-vectoring engine nozzles, and considerable stealth technology. According to press accounts, the FI-X would draw extensively on experience gained in the FS-X program, particularly in the areas of cocured composite structures, stealthy radar-absorbing materials, FBW flight controls, phased-array radar, and so forth. Unlike the FS-X, however, the FI-X is intended to be an all-Japanese program, even for the engine technology, in which Japanese industry has traditionally lagged greatly behind the United States. JDA planners see the FI-X as a potential replacement for ASDF's top-of-the-line McDonnell-Douglas F-15Js. FI-X could evolve into a direct competitor with America's newest fighter,

the stealthy F-22 under development at Lockheed and Boeing. This has caused concerns for some observers:

It's easy to imagine a future where Japan is building high-tech fighter aircraft more capable than anything we have the funding to produce.³⁹

The FS-X Program Contradicts Many Original Pentagon Objectives

With all these considerations in mind, it is difficult to conclude that the collaborative FS-X program is achieving the original Pentagon goals of blocking Japanese indigenous fighter development and inhibiting the emergence of an independent Japanese military aerospace industry. Furthermore, FS-X may also undermine DoD's original objectives for greater rationalization, standardization, and interoperability among U.S. and allied equipment inventories. While FS-X will probably be at least partially interoperable with current U.S. fighters,⁴⁰ it is likely to share relatively few major parts outside of the engine with U.S. Air Force F-16s.

The initial U.S. goal of promoting the most cost-effective solution for upgrading the ASDF fighter inventory is also probably not being achieved with this program. It is difficult to make comparisons, because no one in the United States knows what the FS-X R&D program really costs, and its operational performance capabilities are not yet known. There is also the question of changing exchange rates. However, based on published estimates, R&D is likely to end up costing nearly \$3 billion at ¥115 to the dollar, and this is merely the official R&D budget that many observers believe significantly understates the true development costs. Unit production costs for 130 aircraft have been projected to be in the range of \$60 million but could exceed \$100 million (see Mecham, 1995). This gives a rough total program cost on the order of \$10 billion. In

³⁹Natalie Golding, British-American Security Information Council, quoted in Towle (1993), p. 9.

⁴⁰The concept of interoperability generally applies to communication capabilities, ground support equipment, and consumables, such as fuel and munitions. To the extent that the Japanese develop their own unique national munitions and ground-support equipment, interoperability will be reduced.

August 1991, Korea received the go-ahead for licensed production of 120 advanced versions of the F-16.⁴¹ This deal, which included the cost of GD assistance to Korean industry in defining a future domestic trainer aircraft, was valued at \$5.2 billion in the press (Hutcheson, 1991). In mid-1992, Taiwan reportedly agreed to buy 150 F-16s for about \$6 billion.⁴² While these crude comparisons are hardly definitive, they probably provide a rough sense of relative costs. Furthermore, few U.S. experts believe the initial operational versions of FS-X will dramatically surpass the combat capabilities of recent variants of the F-16.

Finally, the FS-X program will also probably not directly contribute to design solutions for future fighters of interest to the U.S. services or allies, as originally hoped by some DoD officials. The Japanese refused to adopt either the 375- or 400-ft² wing design GD developed for the Agile Falcon. This has become a moot issue, however, since the U.S. Air Force and European allies eventually rejected all the big-wing Agile Falcon proposals, primarily for budgetary reasons. Currently, the only F-16 modification proposals the U.S. Air Force and allies are seriously considering involve changes limited to the avionics and other subsystems.⁴³ The Multi-Role Fighter program, intended to produce a replacement for the U.S. Air Force F-16, has also been delayed well into the next century. Initially slated for program launch in 1994, budgetary constraints have put the program on indefinite hold. The program originally envisioned a major modification and upgrade of the existing F-16 or the development of a totally new design. However, even if it had been funded in 1994, it is extremely unlikely that U.S. developers would have drawn directly on the FS-X or any of its major subsystems for their design proposals (see Opall, 1992).⁴⁴ Ironically, the U.S. Navy is moving ahead with a much

⁴¹The Korean version of the F-16 is based on the Block 50, a considerably more advanced version than the Block 40, which served as the baseline for the FS-X.

⁴²"Taiwanese Want F-16 Trade-Off" (1993).

⁴³See "Belgium, Netherlands Sign for F-16 Update" (1993).

⁴⁴In the summer of 1993, the defense press reported that Lockheed was offering the Air Force a new modification of the F-16 to enter service after 2010 as the Multi-Role Fighter. This variant, called the F-16X, reportedly would be equipped with new wings, similar to those of the Lockheed F-22, and advanced avionics. Several innovations the Israelis developed reportedly would be

more radically modified Hornet, the F-18E/F, which will include a new composite wing. This design, however, has evolved away from the Super Hornet proposals McDonnell-Douglas originally offered Japan back in 1986 and 1987. Therefore, even if the Japanese had selected the F-18 as the basis for the FS-X, it is doubtful that the resulting Japanese modifications would have contributed directly to the U.S. Navy upgrade program.

In sum, the Pentagon may have won the battle in 1987 but lost the war in the long run on the question of Japanese indigenous fighter development. According to one leading U.S. expert, the FS-X program has "largely satisfied" Japan's objectives by moving its aircraft manufacturers "one step closer to their goal of becoming global competitors." (Chinworth, 1992, p. 160.) But this is not the outcome that critics like Clyde Prestowitz and others feared back in 1989. Indeed, their criticisms contributed to the current form of the program. FS-X is contributing only indirectly to the expansion of Japanese industry's capabilities in commercial aerospace. Collaboration with Boeing and other foreign companies on such programs as the B.777 airliner probably serves that purpose much more effectively. Rather, FS-X is providing the critical design and development experience Japanese firms need to become serious contenders in the big leagues of fighter aircraft and military subsystem development. At the same time, FS-X is contributing relatively little toward advancing the Pentagon's original goals of greater equipment standardization and increased burden-sharing among allies in the procurement of new weapon systems.

NEXT STEPS

Given this history of mixed outcomes, the question naturally arises: Should the U.S. government seek the continuation of the FS-X program into production? Ironically, all the evidence suggests that the answer is a definite yes. Now that development of FS-X is nearly completed, full production of the aircraft is necessary to promote U.S. security and economic interests. Many of the potentially most important economic, technological, and political benefits of the overall program depend on the FS-X entering into

incorporated into the design proposal. However, Lockheed apparently drew nothing from the FS-X program for possible use in this new variant. See Sweetman (1993).

series production. With R&D nearly complete, cancellation of the program before production would be the worst possible outcome from the U.S. perspective.

Benefits of Production for the United States

The most obvious benefits are in income and jobs. Two-thirds or more of the total program revenue for U.S. industry is expected to be generated during the manufacturing phase. It has been estimated that FS-X production will provide nearly ten times as many man-years of employment for highly skilled U.S. aerospace workers as the development phase.

The production phase may also be crucial for the more effective transfer of interesting Japanese process technology—if indeed any exists—to U.S. industry. As noted above, low-cost, high-yield Japanese manufacturing techniques for the composite wing box and the MELCO T/R modules have been the primary areas of Pentagon interest in FS-X technology since at least 1987. Most engineers would argue that process technology is best learned by doing. This is why GD and U.S. government negotiators fought so hard during the 1988 MoU negotiations to win the right to manufacture two of the six prototype wing sets at Fort Worth. However, it is not clear that the complete process for manufacturing the cocured composite wing during series production will fully mature during the R&D phase. Mitsubishi is still largely experimenting with tooling and manufacturing approaches during the wing development program. Undoubtedly, the tooling and manufacturing processes will be refined considerably more during the actual production phase. Thus, full transfer of the process technology may require significant U.S. industry involvement in series production.

Finally, failure of the FS-X to enter production could wipe out the single most important political and military benefit of the program as originally conceived by the Pentagon: formal and extensive American involvement in the most important Japanese military procurement program of the 1990s. The FS-X program is not resulting in the minimally modified F-16 that American officials originally hoped for, but neither is it a fully indigenous fighter designed and developed wholly by Japan. More importantly, U.S. government and industry personnel are involved in major aspects of the program on every level.

Production of the FS-X potentially guarantees an important U.S. role well into the next century, on both the government and industry levels, in ASDF procurement policies and in the overall evolution of the Japanese military aerospace industry. It can provide a unprecedented "window" on the future development of Japanese military technologies and capabilities. Continued joint FS-X program management potentially offers a unique forum for influencing Japanese policy, as well as for encouraging greater technological sharing and cooperation.

The currently planned production of FS-X, plus the possible future development of upgraded versions that are already being examined by TRDI and ASDF, could eliminate the rationale for launching an all-new indigenous fighter development program for years to come. As FS-X enters production in a post-Cold War environment of constrained defense budgets, it is likely to be increasingly viewed as a viable candidate for meeting other important ASDF replacement needs. The prospect of lengthening the production run and developing different versions of the aircraft will undercut those who advocate indigenous development of an all-new advanced trainer or even possibly an F-4E*Jkai* or an early F-15 replacement. As a result, the American government and U.S. industry could find themselves directly involved for years to come in a much broader array of major ASDF procurement programs than originally anticipated.

But the U.S. side may have to change its approach to the program to realize these potential benefits fully. A continued U.S. emphasis on technology transfer issues and access to Japanese technology could delay negotiations for the production phase and lead to a nominal production run or outright cancellation of the program. This would have adverse effects on U.S. security and economic interests, as discussed in detail below.

Risks of Cancellation

During the debate over FS-X in 1989, some U.S. skeptics remained dissatisfied with the provisions of the agreement dealing with FS-X production. Their criticism centered on the failure of the FS-X accords to require Japan to enter into production. They pointed out that nothing in the MoU, the side letters, or other program agreements committed the Japanese government to manufac-

turing and procuring the FS-X once development is completed.⁴⁵ They argued that the Japanese could use the FS-X R&D program as a relatively low-risk dry run for full-scale indigenous development at a later date. With the F-16 TDP in hand and the assistance of seasoned U.S. contractors, Japanese firms could gain invaluable experience in the demanding task of fighter development, integration, and testing. Upon completion of R&D, the Japanese government would cancel the production phase, citing a reduced threat, escalating costs, technological problems, or friction over technology transfer. Soon thereafter, the skeptics warned, Japan would launch an ambitious indigenous fighter program that would make use of the experience gained during FS-X R&D and would be unencumbered by American participation and constraints.

The majority of U.S. program officials have always considered this unpleasant scenario to be rather far-fetched and paranoid. They point out that replacement of the aging Mitsubishi F-1 support fighter, already long delayed, must begin at the end of the 1990s. This replacement schedule does not leave sufficient time to develop a new indigenous fighter. Furthermore, with F-15 and P-3 licensed production ending in the latter half of the decade, Japanese industry will need a major new production program at that time to keep their factories and workers employed. Perhaps most importantly, U.S. officials insist that Japan's leadership would not risk the political breach with the United States that would likely result from a decision not to go into production.

While these arguments are compelling, a Japanese decision to forgo production of the FS-X is hardly inconceivable, particularly in view of the growing downward pressure on the Japanese defense budget following the collapse of the Soviet Union. Much depends on the final outcome of the R&D program in terms of cost and aircraft performance, as well as on the continuing evolution of the cooperative arrangements with the U.S. side, particularly in the area of technology transfer. While the government has already authorized nearly all the funding for the formal R&D phase, years of prototype flight testing and other developmental tasks will still have to be financed. No one knows how well the aircraft will per-

⁴⁵However, Japan is obligated to pay cancellation fees to the U.S. government and industry if the program does not enter the production phase.

form once flight testing has begun. The all-composite wing, the complex new avionics, the flight-control system, and many other technological aspects of the aircraft are still considered to be areas of relatively high risk for Japanese industry in which unforeseen technical problems may still arise. Friction with the United States over the technology flowback and stepped up efforts to gain access to Japanese technology may also undermine the program. Finally, negotiations over the production MoU itself are likely to prove difficult and may diminish Japanese support for the production phase.

Any possibility, no matter how remote, that production may not take place should be cause for considerable concern on the U.S. side. While outright cancellation may be unlikely, a small nominal production run of 40 to 60 aircraft is a real possibility. With cancellation or a limited FS-X production program, Japanese industry would be presented with a variety of attractive new options for indigenous development free of any direct American involvement.

In short, the bulk of the potential economic, technological, and political-military benefits for the United States from the FS-X program may depend on ensuring that this fighter enters into full series production. Most of the income and jobs will come from the production phase. Full transfer of Japanese process technology may require extensive U.S. industry involvement in production. Perhaps more important, FS-X production may help reduce the incentives for development of an all-new Japanese fighter for many years to come and may permit the United States to remain fully engaged in the evolution of the Japanese military aerospace industry. But these benefits will not automatically arise if Japan decides to go ahead with production. Rather, their realization will in large measure depend on the specific content of the production MoU that the two sides negotiate.

How to Do Better

The United States needs to make the FS-X program work better and ensure that full series production takes place. How can this be done? The U.S. government should develop a carefully thought-out and well-coordinated high-level strategy to guide negotiations over the content of a production MoU. Without careful

planning and preparation, the U.S. side risks further disruptions and disappointments on the program.

U.S. program officials spent countless frustrating hours in the early stages of the R&D program debating with their Japanese counterparts the precise meaning of specific words or phrases in the original agreements. Entire new documents had to be negotiated just to clarify various aspects of the original MoU. Therefore, the U.S. side would be well advised to enter into the new negotiations with a clear understanding of its objectives and priorities and to make sure they are explicitly spelled out in the MoU. Important words and phrases should be defined with great care and precision.

Our research indicates that the United States should also consider reducing the emphasis it has placed on the legalistic aspects of technology flowback and access and should adopt a flexible approach to the question of workshare percentages during production and the allocation of specific work tasks.

Continuing disputes over technology flowback and access could seriously delay the negotiations for a production MoU. The American side needs to stand back and seriously review this question from the technological and political perspectives. It should review both the potential costs and benefits and the practical feasibility of gaining real benefit from Japanese technology through the mechanisms established in this program. The U.S. government should seek to determine which U.S. companies—if any—are seriously interested in the Japanese technologies that might be made available through the program. The challenge to the American side will be to determine a way to resolve legalistic disputes over technology access without causing political disruption to the program, while enhancing the prospects for meaningful access to interesting Japanese technologies.

Another cluster of problems involves the question of achieving the mandated 40 percent of the production budget for American industry and the actual division of specific work tasks during production. The side letters negotiated by the Bush administration during the FS-X clarification process guarantee U.S. industry a 40-percent share of production work. Achieving this will undoubtedly prove to be one of the most politically challenging and sensitive aspects of the negotiations. The problem of assigning specific work tasks during the production phase may be difficult to resolve. For a variety of reasons, it is likely that negotiators will be forced to

assign work tasks for the production phase somewhat differently than the tasks were assigned for R&D, which could cause significant difficulties.

This is an additional reason that both government and industry need to devote greater resources to assessing Japanese derived and nonderived data. The negotiations over production work division may be difficult. The Japanese will know exactly what they want to get out of the negotiations. The U.S. side should enter the negotiations with a clear idea of what tasks the United States would like to be allocated and why. If careful examination of Japanese data indicates that there may be manufacturing processes or technologies of genuine interest, the American side should consider targeting these areas for production to ensure their effective transfer.⁴⁶

The bottom line for U.S. negotiators, however, should be to remain focused on maintaining and encouraging continued U.S.-Japan procurement collaboration for ASDF's next fighter. The American side must avoid at all costs the fundamental mistake of permitting legalistic disputes over abstract rights of U.S. access to Japanese technology—rights that may never be fully exercised—to undermine the continued survival and full series production of the FS-X. If the FS-X is canceled or only produced in relatively small numbers, it is only a matter of time before the all-Japanese FI-X or some other indigenous fighter takes its place.

⁴⁶Nothing in the existing FS-X agreements prohibits the U.S. side from seeking participation in the manufacture of any part of the aircraft, no matter who led development during the R&D phase. Thus, the requirement for a 40-percent U.S. share could in principle be used as leverage to gain access to manufacturing techniques in any area of interest. For example, it appears doubtful that MELCO's manufacturing processes for the T/R modules, so highly touted during the 1989 debates, will ever be fully transferred unless a U.S. company takes part in their manufacture. Tens of thousands of T/R modules will be needed during the production phase. If the process technology really appears interesting to U.S. experts, the U.S. could seek to produce some or all of the T/R modules under license.

RETHINKING COLLABORATION

INTRODUCTION

The FS-X is the first and only large-scale program the United States has undertaken with a foreign country for cooperative development of a major weapon system intended for series production. Given this unique status, many problems and difficulties were to be expected. The FS-X has been, and continues to be, an important learning experience for both sides. It provides many lessons for U.S. policymakers on the value of cooperative development programs and how to conduct them in the future. Among the most important are highly controversial questions of technology transfer and access during collaboration programs and the long-term effects on the U.S. defense industrial base. Many on the U.S. side had hoped that the FS-X program would serve as a model for gaining access to advanced Japanese dual-use technologies that would prove highly beneficial to the U.S. defense industrial base. Other American officials had supported the program as an effective means of restraining the growth of a broadly capable and more independent military aerospace industry in Japan, which might eventually provide unwelcome competition for U.S. defense industries and provide support for a more autonomous Japanese defense posture.

As we saw in Chapter Twelve, after nearly four years of the full-scale development effort, the FS-X program appears to be falling short of original expectations in these areas and others. Lingering feelings of bitterness remain on both sides over the many disputes that have taken place throughout the history of the endeavor. Indeed, one senior Japanese defense expert recently for-

mulated the following metric for judging the final outcome of the program: "It will be a success if we never repeat it again!"¹ One former high-level Reagan administration official still believes that the FS-X controversy caused "perhaps irreparable damage" to the U.S.-Japan relationship.² With such views still widespread, American policymakers should obviously strive to avoid repeating the mistakes made on this program in the past. Many of the problems encountered during the program appear to have arisen from basic flaws in the strategies that Congress pushed and that the Pentagon and other government agencies pursued. Clearly, the FS-X experience suggests that the U.S. government needs to rethink its policies toward weapon development collaboration in general and technology transfer on such programs in particular.

This chapter examines what went wrong with the FS-X collaboration program and presents some lessons learned for future collaborative weapon development programs.

"SNATCHING DEFEAT FROM THE JAWS OF VICTORY"

Given the assessment in Chapter Twelve regarding the transformation of the FS-X, the question remains, in the words of one observer: How did the U.S. government succeed in "snatching defeat from the jaws of victory"? (Prestowitz, 1989a, p. 31.) Several elements seemed to have contributed to this outcome. The first concerns the priorities and the attitudes of the senior DoD officials who negotiated the original deal. The number-one objective of high-level Pentagon officials from 1985 through 1987 was to win major U.S. government and industry involvement in the program. This was a critically important objective that the U.S. side achieved. Little thought, however, seems to have been directed toward developing a detailed strategy for negotiating the specific

¹Statement by Tetsuo Tamama, Japan Defense Research Council, at the U.S./Japan Economic Agenda's *Conference on High Technology Policy-Making in Japan and the United States: Case Studies of the HDTV and FSX Controversies*, Georgetown University, Washington, D.C., June 8, 1993.

²Statement by Richard Armitage at the U.S./Japan Economic Agenda's *Conference on High Technology Policy-Making in Japan and the United States: Case Studies of the HDTV and FSX Controversies*, Georgetown University, Washington, D.C., June 8, 1993.

structure and content of a collaborative program. U.S. officials seem to have held an exaggerated view of the level of influence they could exercise over the details of the program once the principle of U.S. involvement had been accepted. They appear to have assumed that, with American participation, other U.S. objectives for the program would naturally be implemented.

Some observers have argued that senior Pentagon officials sought American participation as an overarching end in itself, as a symbol of the continuity of the existing lopsided U.S.-Japan security relationship, and to satisfy the short-term economic concerns of Congress and industry.³ This view holds that the Pentagon leadership considered other objectives traditionally advanced in support of equipment collaboration—such as R&D burden-sharing, increased interoperability, technology access, and lower procurement costs—“nice to have” but relatively less important than the fundamental political principle of U.S. involvement. Thus, it is argued, U.S. officials were not particularly concerned with the extent of the modifications undertaken.

Yet many U.S. officials were clearly upset during the early days of the MoU negotiations about the potential opportunities the FS-X program provided for Japanese industry to expand its military R&D capabilities. For example, one senior DoD official warned in an internal memorandum written in January 1988 that:

While the current program is called joint development, it provides Japan with complete authority for design and configuration decisions. Since the Japanese have already decided that most major components will be Japanese (apparently forgetting years of U.S. industry assistance) there may not be much left for our defense industries.⁴

Such concerns contributed to the explicit reconfirmation by the DoD and DoC during the 1989 interagency review of a policy of minimizing changes to the baseline F-16 design and maximizing use of standard F-16 components and parts on the FS-X.

³Prestowitz advances a version of this interpretation, which is also held by some working-level U.S. officials on the program (Prestowitz, 1989a, pp. 32–33).

⁴Memorandum from Deputy Under Secretary of Defense Stephen Bryen to the Under Secretary of Defense for Policy, January 19, 1988, quoted in Prestowitz (1989a), p. 37.

Thus, the most likely explanation of the evolution of the program is that the Japanese proponents of *kokusanka* simply outmaneuvered and outlasted the Americans. The original agreement as signed in late 1988 clearly left considerable flexibility in the actual implementation of the program. The Japanese were left in a particularly strong position to exercise control over design, configuration, and technology applications because MHI had won the undisputed role of lead contractor. Yet American officials could be excused for assuming the U.S. side would still be able to influence these matters. In principle, the TSC and other elements of program oversight at the government level had been structured in a way that gave the U.S. side a significant voice in the conduct of the program. Many American officials believed that, whatever the formal structure of the industry relationships, the vastly greater store of R&D experience and technological expertise that U.S. industry possessed would in practice place GD and other American firms in a dominant position.

In practice, however, things have not worked out as at least some Americans had assumed. First and foremost, U.S. officials failed to appreciate the depth of the Japanese commitment to the broad objectives of *kokusanka*, and, even more important, they significantly underestimated the technological capability of Japanese industry to carry out those objectives. Once senior U.S. officials had established the broad parameters of the program, they left the details and the actual program implementation to working-level officials representing a variety of governmental authorities. No single overarching policy guidance was developed to coordinate and harmonize the actions of the various officials involved in the program, who represented a variety of agencies, often with differing agendas and priorities. As one working-level official noted, once the overall agreements had been signed, FS-X soon became an "orphan program," with relatively low-level officials left largely to their own devices.⁵

A similar situation also developed on the Japanese side but with much different results. The major decisions about the FS-X program were made on the highest political levels in Japan. The Japanese political leadership was not willing to risk a possible breach in the overall security relationship with the United States

⁵Interview with a U.S. Air Force program official.

over the issue of indigenous development. It forced the *kokusanka* supporters to accept a program based on the cooperative modification of the F-16. But detailed negotiations and program implementation were left to JDA, the Air Staff, TRDI, and industry, with occasional intervention from MITI and other ministries. These agencies represented "the heart of the *kokusanka* coalition." Unlike their American counterparts, Japanese industry and the government working-level officials were unified in seeking the same basic objective: salvaging as much as possible of the original plan for indigenous development within the confines of a cooperative modification program.

The American side never effectively countered the Japanese strategy. An important Japanese victory had been won in the summer of 1987 when GD accepted all the major Japanese modification proposals and technology applications for the SX-3, with no objections from the Pentagon. Combined with the concession of Japanese industry leadership for the R&D program, the *kokusanka* supporters had gained a strong initial position for carrying out their objectives. The U.S. side, however, still retained considerable potential leverage over the future course of the R&D program. That this leverage was not effectively applied was largely the result of the debate in Congress in the early months of 1989.

The debate significantly shifted the focus of U.S. program officials. Prior to mid-1988, the principal thrust of U.S. policy on FS-X had been to prevent indigenous Japanese fighter development and to ensure Japanese procurement of a cost-effective fighter closely patterned on an American design. Once the Japanese selected the GD SX-3 at the end of 1987, many U.S. officials sought to minimize Japanese changes to the baseline F-16 modification proposal and to coordinate configuration changes with Agile Falcon proposals of possible interest to the U.S. Air Force and European allies. In the spring and summer of 1988, DSAA officials negotiating the MoU came under increasing political pressure from congressional staffers about the direct economic implications of the FS-X agreement. However, it was the 1989 debate that pushed the issues of workshare, U.S. technology transfer, and access to Japanese technologies to the forefront of concerns of U.S. officials involved in FS-X.

By the fall of 1989, these economic questions had grown to such prominence that they almost totally eclipsed the political and

strategic military issues that had originally dominated the Pentagon's approach to the program. Under scrutiny from Congress through the GAO and the DoC with its newly institutionalized involvement in oversight of the program, the Air Force and Pentagon officials responsible for implementing the American side of the project tended to focus on the highly politicized issues of workshare and the two-way flow of technology. This change in attitude is illustrated by the timidity with which the U.S. side advanced the proposal for an enlarged wing design in September to coordinate development with the new Agile Falcon proposal and the quick American retreat when confronted with Japanese opposition. After the bruising battle in Congress over FS-X, U.S. program officials did not want to risk another public controversy with Japan over the FS-X wing design.

These changed circumstances enabled the Japanese working-level advocates of *kokusanka* to salvage considerably more of their original objectives for developing the Rising Sun fighter within the context of the cooperative FS-X program than might otherwise have been the case. While the two sides remained locked in debate throughout 1989 and into 1990 over questions of technology transfer and access, TRDI and Japanese industry proceeded with the R&D effort in a manner that exploited Japanese control over design, configuration development, and technology application, to develop a far more dramatically modified fighter than originally envisioned by the U.S. side. This transformation generally met with only perfunctory and ineffective American opposition, as U.S. officials remained distracted by the problems of implementing the politically sensitive workshare and technology-transfer agreements that had been central to the 1989 congressional debate. And although American officials achieved considerable success in implementing the mandated U.S. workshare and controlling the transfer of F-16 technology to Japan, their attempts to gain access to Japanese technology made only slow progress. Even worse, U.S. government officials had to pressure U.S. industry constantly to at least act as if it were actually interested in the Japanese technology and data—which it was not.

The U.S. experience with FS-X from 1985 through 1993 has been mixed at best. At points in its history, the program caused unprecedented discord with one of America's most important allies of the postwar era. Many of the benefits U.S. officials had hoped

to acquire through the program have proven difficult to achieve. With the completion of the R&D effort now in sight, U.S. policymakers will soon face critical new decision points. It is important to begin applying the broad lessons learned from the history of the program to its future course. Perhaps more important, it may be time to rethink the Pentagon's traditional approach toward cooperative weapon procurement programs with allies.

GAINING ACCESS TO FOREIGN TECHNOLOGIES

Lessons Learned from FS-X

The basic lesson from FS-X on technology transfer and cooperative R&D is simple. Without a strong confluence of perceived interests, particularly among the participating industries and military R&D establishments on both sides, the mutually beneficial sharing of technology and R&D expertise is difficult to implement. Imposing collaboration from above on a reluctant or unwilling partner is not a guaranteed recipe for success. While American officials should continue to pursue every reasonable avenue for gaining access to potentially useful Japanese technologies through the FS-X program, they should also seek to structure future programs in ways that will more naturally promote a mutually beneficial two-way flow of technology. More effective technology sharing would emerge from programs that involve

- Foreign partners who possess technology or data that are of clear potential importance to American weapons development, and who are willing to share it
- Industry partners who actively seek collaboration and offer complementary technological strengths and contributions
- Genuine interest from a military service on both sides in developing the technology or procuring the resulting weapon system
- Genuinely collaborative R&D
- Equity in technology access and restrictions
- Financial contributions from all participating governments equal to workshare.

In light of these features of successful collaborative efforts, the FS-X experience falls short. It adds to the impression that the Pentagon strategy during the 1980s for acquiring Japanese defense-related technology was fundamentally flawed. Its most serious shortcoming is that it failed to recognize the importance of mutually perceived benefit in the successful sharing of technology. An effective two-way transfer of technology requires that both sides initiate active and voluntary participation, each motivated by the belief that collaboration will result in a significant net technological gain. Such a situation arises when both participants can make technological and financial contributions to the joint effort that complement each other and directly assist each side in achieving its own objectives.

However, the fact that these features were missing from the FS-X collaborative effort does not mean that they cannot be achieved. The example of X-31 collaborative effort between the United States and Germany provides a useful counterpoint.⁶

The Case of the X-31 Fighter Technology Demonstrator

The development of the X-31 fighter technology demonstrator is particularly interesting because it represents the first example of true *ab initio* international codevelopment of a military aircraft involving the United States. The X-31 is a fighterlike test aircraft developed to explore the enabling technologies and the operational utility of radical improvements in fighter maneuverability. Unlike the FS-X, the X-31 is only a technology demonstrator and will never be fully developed and series-produced as an operational weapon system. Nonetheless, the technological and organizational challenges encountered in the design, development, manufacture, and flight testing of the two X-31 prototype aircraft in many respects parallel those encountered on a typical fighter R&D program. Indeed, designers consciously patterned the X-31 configura-

⁶This account is based on unpublished research conducted by the author in 1992. Competent overviews of the program can be found in Lerner (1991), Wanstall and Wilson (1990), and "X-31: The Wonder Plane" (1990).

tion on a serious design concept for a future European combat fighter.⁷

The X-31 aircraft was developed and manufactured collaboratively in the late 1980s by Rockwell International in the United States and Messerschmitt-Bölkow-Blohm (MBB) in Germany, now part of Deutsche Aerospace. The program is sponsored and funded by the U.S. Advanced Research Projects Agency and the German Ministry of Defense. On the American side, the U.S. Navy acts as the executive authority, while the U.S. Air Force and NASA cooperate closely with the program.

The X-31 required designing, developing, and integrating a variety of advanced technologies and subsystems into a unique aerodynamic configuration that provided highly unorthodox maneuvering capabilities for use during air combat. Among the most important technological challenges during X-31 development were the overall aerodynamic design configuration, the remarkably complex flight-control system, and the novel thrust-vectoring system using carbon-carbon composite paddles attached to the tail pipe. Program officials and technical experts on both sides of the Atlantic unanimously agree that the R&D program generated a substantial two-way flow of technology and expertise. All the U.S. program managers involved in developing the aircraft believe the Germans transferred technology, data, and know-how equal to or greater than that transferred from the United States.⁸ Yet the R&D program encountered few major problems and virtually no disputes from either side over technology transfer.

Program officials on both sides agree that the strong perception of mutual technological benefit, particularly on the industry level, was the key to promoting successful technology reciprocity. Both parties brought substantial technical data and R&D experience to

⁷In the late 1970s, German industry developed a design concept based on a delta-canard configuration called the TKF (*Taktisches Kampflugzeug* [tactical combat aircraft]) as a candidate for a future collaborative European fighter. While the general TKF design configuration eventually served as the basis for the EFA, the European governments rejected the German industry requirement for including unorthodox maneuvering capabilities. The Germans then sought to develop a prototype patterned after the TKF design jointly with the Americans to demonstrate the technological and operational feasibility of supermaneuverability. This effort led to the initiation of the X-31 program.

⁸Based on multiple interviews with U.S. Air Force program officials in 1991 and 1992.

the X-31 program from prior national programs that were complementary, and they freely shared it. MBB had conducted years of independent wind-tunnel tests and simulation studies on various aerodynamic configurations.⁹ Most important, the Germans had developed the basic design concept for supermaneuverability on which the X-31 would be based and offered it to the Americans. Rockwell had also conducted considerable R&D on novel configurations for enhanced fighter maneuverability, including work with an unmanned flying technology demonstrator, the Highly Maneuverable Technology vehicle.

On their own initiative, the two firms undertook collaborative exploratory research from 1981 through 1984, financed with corporate funds. After gaining interest in their novel concepts from elements within the U.S. Air Force R&D community and elsewhere, the two companies successfully sought funding from their respective governments in 1985 for a joint feasibility study. In June 1986, U.S. and German government officials signed a Memorandum of Agreement for the cooperative funding and development of the X-31.

The remarkably brief and simple Memorandum of Agreement calls for "a fair and cooperative research, design, and flight test program of [X-31] technologies." Indeed, the hallmark of the X-31 program was collaboration on virtually all key aspects of the R&D effort, including the maximum feasible sharing of the resulting data within the normal constraints of each country's national disclosure policies. As an example, the primary technical challenge during the initial phase of R&D was developing the basic X-31 configuration. Rockwell and MBB split the total effort that went into configuration development almost equally, as measured in engineering man hours. The basic wing configuration and leading-edge sweep derived from MBB's extensive database on its J-90/P-30 fighter concept, but Rockwell developed the detailed shape of the airfoil involving wing twist, camber, thickness, and so forth. On the digital FBW flight-control system—a system far more complex and challenging than that required for the FS-X—the Germans generated the basic control laws, an American subcontractor wrote the code, a U.S. vendor supplied the computer,

⁹Additional studies were conducted collaboratively with McDonnell-Douglas in the late 1970s.

and Rockwell and MBB integrated and refined the overall system in close collaboration.¹⁰

The experience with the X-31 R&D program dramatically contrasts with the history of the FS-X program. Whereas both X-31 partners brought their own complementary technology, data, and expertise to the program and worked closely on virtually all aspects of the full-scale development phase, the FS-X participants became mired in disputes over technology transfer and access, with U.S. industry essentially shut out of many of the most important areas of design and development. Through the X-31 program, the United States is gaining a potentially valuable new complex of military technologies and operational concepts, much of it based on German contributions. While the Japanese are now transferring much data from the FS-X program to the U.S. side, its ultimate value and benefit remain uncertain.

The most fundamental difference between the two programs can be found in the basic interests and motivations of the participants, especially on the industry level. The X-31 started solely at the initiative of two companies that saw economic and technological benefit in working together and sharing their technological know-how to advance their common objectives. Joint government funding was won only later, when officials in the military R&D establishments and armed services on both sides of the Atlantic were convinced of the potential military benefits of exploring the new technologies jointly.

In the case of FS-X, Japanese industry and most of the military R&D establishment vehemently opposed collaboration with the United States. They saw nothing of great benefit they would gain through U.S. participation, but much that they could lose. Many Japanese suspected that the U.S. government sought only to suppress the further development of their domestic military aerospace industry and to gain unfair access to their own commercially valuable technology. The ASDF was also generally not enthusiastic about joint development. For its part, American industry supported collaboration, but primarily as a means of winning participation on a potentially lucrative program from which it otherwise

¹⁰Based on multiple interviews with M. R. Robinson, Director, Advanced Systems & Technology Development Programs, Rockwell International, and Hannes Ross, Manager, Advanced Design, MBB-Deutsche Aerospace, in 1992.

would be excluded. U.S. companies did not generally believe the Japanese side had a great deal to offer in the way of new technologies or know-how, with the possible exception of the cocured wing. At most, they hoped that Japanese money could be used to help them develop versions of existing aircraft that later might be sold to the U.S. services or other allies. There are few indications that, in the early stages of the program, the U.S. Air Force or any of the other services viewed FS-X as an important means of acquiring significant new technologies.

The U.S. government, rather than industry or the services, led the effort to guarantee access to Japanese technology through the FS-X program. Yet this effort had a major symbolic political component. Many Pentagon officials were concerned about the mounting criticism from Congress and elsewhere that past licensed-production programs represented a one-way transfer of advanced aerospace technology to America's economic competitors. Greater technology reciprocity on FS-X could help counter these criticisms. Yet, in the early phases of the program, government officials expended relatively little effort identifying specific Japanese technologies that might be of interest to U.S. industry or the services. The emphasis on the MELCO APA radar and the cocured wing arose relatively late in the negotiating process, in part as a response to congressional criticism over the lack of technology reciprocity. U.S. officials initially targeted the radar in part because it was the only Japanese avionics system planned for the FS-X about which they knew some details. Government officials also did not carefully think through the details of a realistic and practical mechanism through which Japanese technology could be transferred and successfully applied to U.S. programs until the program was well under way. Once the final deal was sealed, implementation of the program was handed over to the U.S. Air Force, with little specific guidance on how to make it work.

CODEVELOPMENT PROLIFERATES MILITARY R&D CAPABILITIES

A second lesson of the FS-X experience is that cooperative military development programs carry the potential for significantly aiding a foreign country that is trying to increase its independent military R&D capabilities. In the long run, such programs can lead

to a reduction of U.S. influence over the security policies of important allies and can help establish competitive foreign defense industries that may undermine the U.S. defense industrial base. Licensed production, on the other hand, usually transfers little technology of significant commercial value to advanced industrial countries like Japan and does little to promote the design and development know-how necessary to develop modern weapon systems. If codevelopment is the only alternative, it must be structured and managed very carefully from the U.S. side to minimize these risks.

Particular attention needs to be focused on the question of the transfer of expertise—as opposed to technology—during cooperative military R&D programs. Despite the trend toward globalization in high technology, the United States still possesses significant leads in most military technologies and, more importantly, in the formulation of requirements and the design and integration of sophisticated weapon systems. Codevelopment programs can proliferate the specialized skills built up by America's leading defense contractors throughout the decades when R&D was conducted on a scale far beyond what any other nation could afford.

Much of the basic rationale underlying the Pentagon's policy in the mid-1980s toward the FS-X program remains valid. U.S. political, military, and economic interests are generally not well served by the global proliferation of the technological and industrial capabilities to independently develop advanced weapon systems. This is particularly true in the case of Japan. A continuing buildup of the Japanese defense industrial base while the U.S. draws down its forces in the Pacific could encourage a more autonomous Japanese security posture. It could also fuel regional arms races and promote instability, as South Korea, China, and other neighbors seek to counter newly acquired Japanese capabilities.

An expanding Japanese defense sector may also pose a potential threat to the long-term health of the U.S. defense industrial base. The export of military equipment by Japan is prohibited only by cabinet policy, not by legislation or the constitution. Beginning in the early 1980s, leading Japanese industrialists called for modification of the cabinet ban on military exports. Because of the limited domestic Japanese market for military hardware and the high costs of military R&D, the development of indigenous systems greatly increases pressures for export. The high quality of many of

Japan's defense technologies, particularly those "spun on" from the civilian electronics and other commercial sectors, could represent a major competitive challenge on the world market at a time when U.S. defense contractors may become increasingly dependent on foreign sales.

For these reasons, DoD officials in the Reagan administration were justified in seeking to discourage indigenous development of the FS-X. And they did not unfairly single out Japan. Throughout the 1980s, they launched several major efforts to convince the United Kingdom, Germany, Italy, and Spain not to develop the EFA. They tried unsuccessfully to undermine French resolve to develop the Rafale fighter. After a brutal political battle, they finally forced the Israelis to cancel development of their Lavi fighter. They generally refrained from attacking the Swedish Gripen and the Taiwanese Indigenous Defense Fighter, because these are smaller, less-capable aircraft, and because U.S. industry involvement was already massive.

Yet while the Pentagon's ultimate objectives were justifiable from the American perspective, its strategy for implementation was seriously flawed. For a variety of reasons already discussed, the U.S. side lost control of the technological evolution of the FS-X, permitting Japanese industry to modify the basic F-16 design far more than originally anticipated.

One of the most compelling reasons U.S. industry has moved toward licensed production and cooperative development programs that transfer the industry's own expertise and technology is the fear that, if the United States refuses to cooperate, foreign countries will turn to European or other producers for collaborative deals. This argument was used to good effect by the Japanese on FS-X, the Koreans on the Korean Fighter Program, and many other allies. Yet this argument underestimates the political importance of the larger security relationships the United States maintains with allies and the generally superior quality of U.S. weapon systems. With the end of the Cold War, U.S. policymakers should consider more directly and forcefully linking the overall benefits of its security relationships with the need for allies to purchase major American weapon systems. For example, the South Koreans could threaten to collaborate with the French to develop or license-produce a new fighter if the United States restricts industrial offsets. But how credible is this threat? Would the South Korean

government feel confident of French military support if the North Koreans invade? Would South Korean pilots perform better if they were flying French Mirages against North Korean MiGs than they would if they were flying U.S. F-16s or F-18s?

Thus, policymakers need to assess important questions about the proliferation of weapon development capabilities and about economic issues when evaluating cooperative weapon system development programs. U.S. officials might consider easing restrictions on arms exports and tightening controls over cooperative development efforts. Selling even the most advanced and sophisticated weapon systems to allies retains far more control in the long run for the United States over technology proliferation than co-developing a somewhat less capable system that helps move the foreign partner closer to industrial and technological independence in advanced weapon system development. The United States is still the world's leader in defense technology and military R&D. With declining defense budgets, few new major military R&D programs on the horizon, and a dramatically shrinking defense industry, how many years will that leadership position be maintained?

Yet, as demonstrated by the X-31 program, cooperating with technologically advanced allies on basic military R&D in narrowly defined areas can provide significant benefits to both sides. This is particularly true if the United States can clearly identify specific foreign technologies or data that would genuinely contribute to American weapon development and that could be made available to U.S. industry through collaboration. Currently, the United States is pursuing several collaborative programs with Japan under the auspices of the S&TF that are aimed at conducting basic research in specific military technologies.¹¹ Some of these initiatives may turn out to be far better models for a more effective type of military technology collaboration with Japan than the FS-X or the proposed theater missile defense initiative.

The FS-X program and other collaboration ventures with Japan can still be shaped to serve the best long-term military and economic interests of the United States and Japan. They can pro-

¹¹The technologies include millimeter-wave infrared dual-mode seekers, advanced steel manufacturing, ship demagnetization, and ceramic materials for rocket engines and fighting vehicle propulsion systems. See Opall and Usui (1993), p. 3.

vide U.S. involvement in and influence over the development of the defense industrial sector in Japan for many years to come. They could provide an opportunity for the U.S. defense industry to learn from the successes of Japanese defense-industry management and structure and ultimately could contribute to the emergence of more genuinely collaborative and mutually beneficial military R&D between the two countries. They can help cement a stronger military and security relationship with one of America's most important allies in the post-Cold War era. But they could also erupt again into more debilitating and destructive disputes between the two partners over emotional technology-transfer and trade issues.

Much depends on the planning and foresight of the American negotiators, the ability of Congress to assess military technology collaboration programs in an unemotional and rational manner, and the response of the Japanese government.

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