The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry

Investigation No. 332-384

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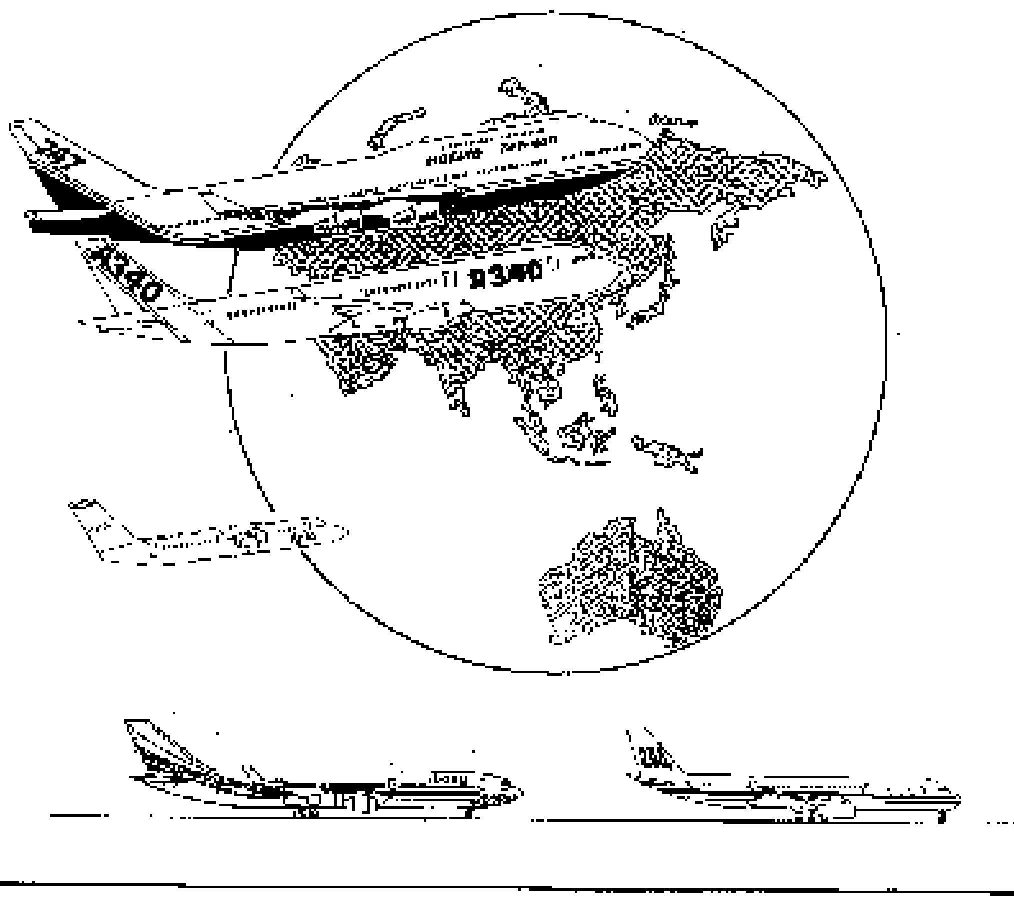

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ABSTRACT

On September 23, 1997, at the request of the House Committee on Ways and Means (Committee),[1] the United States International Trade Commission (Commission) instituted investigation No. 332-384, *The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry,* under section 332(g) of the Tariff Act of 1930, for the purpose of exploring recent developments in the global large civil aircraft (LCA) industry and market. As requested by the Committee, the Commission's report on the investigation is similar in scope to the report submitted to the Senate Committee on Finance by the Commission in August 1993, initiated under section 332(g) of the Tariff Act of 1930 (USITC inv. No. 332-332, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft*, Publication 2667) and includes the following information:

- A description of changes in the structure of the global LCA industry, including the Boeing-McDonnell Douglas merger, the restructuring of Airbus Industrie, the emergence of Russian producers, and the possibility of Asian parts suppliers forming consortia to manufacture complete airframes;

- A description of developments in the global market for aircraft, including the emergence of regional jet aircraft and proposed jumbo jets, and issues involving Open Skies and free flight;

- A description of the implementation and status of the 1992 U.S.-EU Large Civil Aircraft Agreement;

- A description of other significant developments that affect the competitiveness of the U.S. LCA industry; and

- An analysis of the aforementioned structural changes in the LCA industry and market to assess the impact of these changes on the competitiveness of the U.S. LCA industry.

For the last 50 years, the United States has been the leading supplier of LCA to the world. Changes in the structure of the global LCA industry and its market may ultimately affect the U.S. industry's continued dominance, as competition increases and aspiring producers seek to enter the market. The most notable structural change is the merger of Boeing and McDonnell Douglas, which essentially reduced the global LCA industry to two major LCA manufacturers -- Boeing of the United States and Airbus Industrie, a consortium of four European partners, headquartered in France. Boeing has gained significant resources from McDonnell Douglas, but faces numerous challenges as well. The ongoing restructuring of the Airbus business operations could, if successful, significantly lower its cost of doing business and enhance its competitive position vis-à-vis Boeing.

New competition for Boeing and Airbus may come from Russia and/or Asia. While the Russian LCA industry has a long history of aeronautical design and manufacturing for its own and former

[1] The request from the House Committee on Ways and Means is reproduced in full in appendix A.

Soviet bloc markets, capital constraints have caused significant delays in bringing its new designs to market. The industry has nearly collapsed since the breakup of the Soviet Union; industry consolidation and corporate restructuring are essential to the industry's survival. While the current economic crisis in Asia has curtailed the availability of capital, Asian countries remain resolute in their desire to manufacture LCA. Asia's high passenger traffic growth rates are an incentive for Western producers' participation in offset agreements, which would further Asian understanding of aircraft and parts manufacturing processes.

LCA manufacturers are currently exploring two new types of aircraft, the 100- and 500-seat aircraft. New entrants have also focused on the 100-seat aircraft as a strategic niche in which to enter the LCA market. In spite of the strong interest in these new designs, particularly in the 100-seater, their market potential remains unclear.

Copies of the notice of investigation were posted at the Office of the Secretary, U.S. International Trade Commission, Washington, DC 20436, and the notice was published in the *Federal Register* (vol. 62, No. 190) on October 1, 1997.[2] A public hearing was held in conjunction with this investigation on March 17, 1998.[3] Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under other statutory authority covering the same or similar subject matter.

[2] Copies of the Commission's notice of institution and the *Federal Register* notice are included in appendix B.

[3] A list of witnesses who testified at the hearing is included in appendix C.

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Abbreviations and Acronyms

AI(R)	Aero International (Regional)
AIA	Airbus Industrie Asia
AIDC	Aerospace Industrial Development Corporation
Airtech	Aircraft Technology Industries
AMRAI	American Regional Aircraft Industry
AOG	Aircraft on the Ground
ARIA	Aeroflot-Russian International Airlines
ATC	Air Traffic Control
ATM	Air Traffic Management
AVIC	Aviation Industries of China
BAA	Bilateral Aviation Agreement
BAA	Bilateral Airworthiness Agreement
BAe	British Aerospace plc.
BASA	Bilateral Aviation Safety Agreements
CAAC	Civil Aviation Administration of China
CASA	Construcciones Aeronáuticas S.A.
CATIC	China National Aero-Technology Import and Export Corporation
CCQ	Cross-Crew Qualification
CFD	Computational Fluid Dynamics
DOT	U.S. Department of Transportation
DSTP	PT Dua Satu Tiga Puluh
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EU	European Union
Ex-Im	U.S. Export-Import Bank
FAA	U.S. Federal Aviation Administration
FIG	Financial Industrial Group
FSC	Foreign Sales Corporation
G.I.E.	*groupement d'intérêt économique*
GATT	General Agreement on Trade and Tariffs
GosNIIAS	Russian State Scientific Research Institute for Aviation Systems
GPS	Global Positioning System
IPTN	PT Industri Pesawat Terbang Nusantara
JAA	Joint Aviation Authorities
JAR	Joint Airworthiness Requirements
KARI	Korean Aerospace Research Institute
KCDC	Korea Commercial Aircraft Development Consortium
LAAS	Local Area Augmentation Systems
LCA	Large Civil Aircraft
MBB	Messerchmitt-Bölkow-Blohm GmbH
MOU	Memoranda of Understanding
MRO	Maintenance, Repair, and Overhaul
NAS	U.S. National Airspace System
NIIAT	Scientific Research Institute of Aviation Technology and Industrial Engineering
NPV	Net Present Value

Abbreviations and Acronyms*--continued*

NSTB	National Science and Technology Board
R&D	Research and Development
RJ	Regional Jet
RTCA	Radio Technical Commission for Aeronautics/Requirements and Technical Concepts for Aviation
SARI	Shanghai Aircraft Research Institute
SCE	Single Corporate Entity
STAe	Singapore Technologies Aerospace
STPE	Singapore Technologies Precision Engineering
STPL	Singapore Technologies Pte Ltd.
TCAS	Traffic Alert and Collision Avoidance System
TDA	U.S. Trade and Development Agency
TsAGI	Russian Central Aero-Hydrodynamics Institute
TsIAM	Russian Central Institute of Aviation Motors
UHCA	Ultra-High Capacity Aircraft
WTO	World Trade Organization

EXECUTIVE SUMMARY

This study was requested by the House Committee on Ways and Means in a letter dated August 13, 1997. As requested by the Committee, the Commission's report on the investigation is similar in scope to the report submitted to the Senate Committee on Finance by the Commission in August 1993, initiated under section 332(g) of the Tariff Act of 1930 (USITC inv. No. 332-332, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft*, Publication 2667). For the current investigation, the Committee requested the Commission to identify and discuss structural changes in the global large civil aircraft (LCA) industry and market during 1992-97 that have affected the competitive position of the U.S. industry, including the Boeing-McDonnell Douglas merger; the restructuring of Airbus Industrie, G.I.E.; the emergence of Russian LCA producers; the possibility of Asian parts suppliers forming joint ventures and consortia to manufacture complete airframes; the emergence of markets for regional and jumbo jets; and issues involving Open Skies agreements and free flight systems.

LCA are traditionally defined as civil aircraft with more than 100 seats and weighing over 33,000 pounds. The global LCA industry includes two major and one minor producer in the West, as well as two major producers in Russia. The two major Western producers are U.S.-based Boeing Co. and Airbus Industrie, G.I.E., a consortium of four West European producers--Aérospatiale of France, Daimler-Benz Aerospace Airbus of Germany, British Aerospace Airbus Ltd. of the United Kingdom, and Construcciones Aeronáuticas S.A. of Spain. The remaining Western producer, British Aerospace Regional aircraft (United Kingdom), competes only in the lower range (fewer than 128 seats) of the LCA market, and thus is a minor player in the global LCA industry. The two major Russian producers--Ilyushin and Tupolev--have a long history of LCA design and production for their domestic and former Soviet bloc markets, and are interested in expanding to other export markets. Currently, the principal markets for LCA are the United States, Western Europe, and the Asia-Pacific region.

Reflecting the cyclical nature of the global LCA industry, LCA orders nearly quadrupled from the 1994 low of 273 units to 1,054 aircraft in 1997. Orders for narrow-bodied aircraft (with typical seating for fewer than 200 passengers) accounted for 72 percent (761 aircraft) of these orders, demonstrating the dominance of short- to medium-length, low-density flights in current airline route structures. Wide-bodied aircraft (with typical seating for more than 200 passengers), which are often used on high-density routes, accounted for the remaining 28 percent (293 aircraft).

Overview of Competitiveness in the Global LCA Industry

- There has been increasing evidence that operating cost has replaced technology as the primary factor that airlines use to choose aircraft. Although an orientation toward technological progress is still critical, it seems to be directed toward improving productivity within the production process.

- Access to capital from financial markets, government sources, risk-sharing agreements, and foreign investment is the paramount factor that determines competitiveness in the global LCA industry. Other factors that affect competitiveness are design capabilities, manufacturing infrastructure, domestic market demand, corporate structure, market analysis capabilities, purchase price and operating costs, product line and commonality, global support networks, and certification of aircraft to Western airworthiness standards.

The U.S. and West European LCA Industries

- The Boeing-McDonnell Douglas merger created a duopoly in the global LCA market characterized by commodity-type pricing as Boeing and Airbus strive to maintain or gain market share. The emphasis on value rather than technology in airline purchasing decisions has contributed to the current pricing situation. To maintain their competitiveness, airframers are pursuing internal cost-cutting strategies and demanding cost reductions from LCA suppliers, stimulating further supply base consolidation.

- Boeing acquired McDonnell Douglas with the reported intent to soften the cyclical fluctuations of the LCA business and bolster Boeing's position in the shrinking defense industry. Boeing may gain greater financial stability and cash flow; a quick-to-market entry in the 100-seat niche with the addition of the MD-95 jetliner inherited from McDonnell Douglas; and valuable LCA engineering, product development, and production expertise from McDonnell Douglas staff. Boeing faces significant management challenges, however, as it works to merge the different corporate policies and cultures of the two companies.

- Boeing's post-merger performance has been characterized by lagging integration progress and production problems that have led to poor financial performance, customer dissatisfaction, and debt downgrading. Boeing's ability to attain maximum operating potential hinges on its ability to speed post-merger integration and stabilize LCA manufacturing before a strengthened Airbus emerges from its restructuring.

- Although Airbus's current organization as a *groupement d'intérêt économique* (G.I.E.) offers a number of benefits, such as merging the technical strengths of the partners, freeing access to large sums of capital, and pooling a large resource base, the G.I.E. structure lacks centralized management and decision making that contributes to internal inefficiencies and slowed responsiveness. To compete more effectively in the LCA market, Airbus has chosen to restructure into a single corporate entity, which is targeted for completion by the end of 1999.

- The restructuring to a single corporate entity should allow Airbus to become a more formidable, profit-oriented competitor. The consolidation of decision making in a single management structure will likely create a more responsive, efficient corporate organization. Internal conflicts and self-imposed restrictions on operating flexibility, however, may hinder achievement of its full potential.

- While consortia can be an effective means for aircraft manufacturers to develop new aircraft because of the benefits derived from pooling industrial, financial, and research and development assets and sharing risks, the differing cultures, goals, and financial situations of the individual partners raise internal conflicts that can undermine consortia stability. Two such consortia--Aero International (Regional) and Airbus Industrie Asia--were formed to develop a 70-seat and 100-seat aircraft, respectively. Prolonged development problems forced the cancellation of both aircraft programs in 1998.

- Fewer business opportunities exist for suppliers to the LCA industry with the loss of McDonnell Douglas and the lack of new program developments. According to global LCA suppliers, the supplier industry will likely experience further consolidation, increased polarization between Boeing and Airbus, greater diversification into new products and markets, a trend toward vertical integration and preferred supplier relationships, and continued cost-reduction pressures from airframers.

- Although opportunities exist for both airframers to increase sales to former McDonnell Douglas operators, Airbus may be better positioned to gain market share as airlines encourage competition and support a balance between the airframers, as indicated by recent orders. Leading airlines emphasize the need to have two fully competitive players in the LCA market to ensure competitive pricing levels and sufficient aircraft selection.

The Russian LCA Industry

- The Russian LCA industry has devoted all available resources during the last 10 years to develop new LCA capable of competing in the global market with aircraft from Boeing and Airbus. Principally because of a lack of capital and a corporate structure that is not market oriented, Russian producers are not likely to be in a position to secure global market share in the next 10 years.

- The corporate structure of the Russian LCA industry continues to reflect the Soviet-era system of unintegrated design bureaus and production facilities, resulting in disjointed and inefficient operations. The most significant competitive disadvantages resulting from the absence of streamlined corporate structures are reduced access to capital, diminished internal decision-making capabilities, and inhibited ability to get products to market. Capital deficiencies in the Russian LCA industry are presently of such a magnitude that companies cannot meet even their most basic needs, such as worker salaries.

- Other competitive disadvantages facing the Russian LCA industry include the absence of a healthy and reliable supplier industry, deficiencies in market analysis skills and customer support capabilities, no experience in selling and servicing proven aircraft to market-oriented airlines, the inability to offer a wide range of aircraft incorporating common features, a financially strapped domestic market, and a lack of computerization in the design and manufacturing infrastructure.

The Asian Aerospace Industry

- In recent years, China, Korea, Indonesia, Singapore, Japan, and Taiwan have become increasingly involved in aircraft-related programs through international collaboration and indigenous aerospace projects. However, due to the absence of a comprehensive technological base for aircraft development, an overall lack of experience in all phases of an aircraft manufacturing program, and lack of sufficient international and regional cooperation, Asian nations appear unlikely to produce an internationally competitive LCA for at least 15-20 years.

- Government support for the development of their aerospace industries is one of the Asian LCA industries' strongest competitive assets. However, the region's recent economic crisis has limited the availability of capital in Indonesia and Korea, consequently hindering aerospace development in these countries. Korea and Singapore have small domestic markets, which could limit their ability to achieve scale economies on an indigenous aircraft program. China, on the other hand, benefits from both government support for the industry and a large domestic market, which have brought cooperative manufacturing arrangements and transferable skills to the nation's aircraft factories.

- A relatively new development in the LCA industry is the formation of Asian consortia in the 100-seat passenger jet market. Asian aerospace entities are attempting to form cooperative arrangements with neighboring countries and Western producers to augment deficiencies in indigenous aircraft production capabilities and distribute the risks of participation in an aircraft program. While a number of potential cooperative programs have been discussed and some preliminary agreements have been signed, Asian consortia have thus far made little progress.

The LCA Market

- Increased price competition and resulting cost pressures within the airline industry have demonstrated a need for an airliner designed specifically for the 100-seat market. Further development of the market for this aircraft is likely to benefit Boeing and the U.S. aerospace industry. Of the prospective entrants, Boeing is currently the manufacturer closest to introducing an aircraft specifically designed as a 100-seater. Heightened competition in this product niche would likely put comparatively more pressure on any regional (19-70 seat) aircraft manufacturers in the market, and make it more difficult for new producers--particularly those from Asian countries--to succeed.

- In the short to medium term, it is unlikely that an Airbus product will threaten Boeing's dominance in the over 400-seat market (the 747). Airbus plans to develop the A3XX, an entirely new ultra-high capacity aircraft, to address the projected market above that occupied by Boeing's current 747. Although the size of that market may ultimately be somewhat smaller than early projections indicated, Airbus needs a complete family of aircraft to enhance its competitive position vis-à-vis Boeing. Boeing plans to develop a stretched model of the 747 to enter the lower end of the ultra-high capacity market; such an aircraft will cost Boeing substantially less to develop than a completely new aircraft. In the longer term, it is possible that a smaller derivative of the Airbus A3XX could provide competition for a stretched 747 model.

- Changes in external market factors, such as new bilateral agreements that govern international traffic and developments in the air traffic control system, are not likely to affect Boeing or Airbus differently. New bilateral Open Skies arrangements will increase the freedom of airlines to choose and expand service on international routes, and the eventual adoption of free flight will force the air traffic control system to handle increased air traffic. As these changes are implemented, they will affect airline flight frequency and routing, and help to determine the number and types of aircraft commercial airlines will operate.

CHAPTER 1
INTRODUCTION

Scope of the Report

Following receipt of a request[4] on August 18, 1997, from the House Committee on Ways and Means (Committee), the United States International Trade Commission (Commission) instituted investigation No. 332-384, *The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry*, on September 23, 1997. The Committee requested that the study be carried out pursuant to section 332(g) of the Tariff Act of 1930.

The Committee asked the Commission to explore recent developments in the global large civil aircraft (LCA)[5] industry during 1992-97,[6] including The Boeing Co. (Boeing)-McDonnell Douglas Corp. (McDonnell Douglas) merger; the restructuring of Airbus Industrie, G.I.E. (Airbus); the emergence of Russian LCA producers and the possibility of Asian parts suppliers forming joint ventures and consortia to manufacture complete airframes; the emergence of markets for regional and jumbo jets; and issues involving Open Skies agreements and free flight systems.

The global LCA industry has traditionally included manufacturers of civil aircraft with more than 100 seats and weighing over 33,000 pounds. It includes two major and one minor producer in the West, as well as two major producers in Russia. Currently, the principal markets for LCA are the United States, Western Europe, and the Asia-Pacific region.

The two major Western producers are U.S.-owned Boeing and Airbus, a consortium of four West European producers--Aérospatiale of France, Daimler-Benz Aerospace Airbus of Germany, British Aerospace Airbus Ltd. of the United Kingdom, and Construcciones Aeronáuticas S.A. of Spain. The remaining Western producer, British Aerospace Regional Aircraft (United Kingdom), competes only in the lower range (fewer than 128 seats) of the LCA market, and thus is a minor player in the global LCA industry. The two major Russian producers--Ilyushin and Tupolev--have a long history of LCA design and production for their domestic and former Soviet bloc markets, and are interested in expanding to other export markets.

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[4] In its request, the Committee indicated that it was seeking a report similar in scope to the report submitted to the Senate Committee on Finance by the U.S. International Trade Commission in August 1993. That report was initiated under section 332(g) of the Tariff Act of 1930 (USITC inv. No. 332-332, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft*, Publication 2667).

[5] Page ix contains a list of acronyms used in this report.

[6] In many cases, events of 1998 are also discussed.

Approach of the Study

Many sources of information were consulted for this analysis. Among these were in-person and telephone interviews with domestic and foreign LCA and major subassembly manufacturers, industry associations, airlines, and domestic and foreign government officials. Interviews and plant visits were conducted in Belgium, China, France, Germany, Indonesia, Korea, Singapore, Russia, the United Kingdom, and the United States. To gather information on changes in demand for LCA, questionnaires were sent to the leading airlines based in the U.S., West European, and Asia-Pacific markets. A public hearing was held on March 17, 1998, and testimony from hearing and posthearing statements was integrated into this report.

Both qualitative and quantitative analyses were conducted to evaluate the factors that affect the competitiveness of the U.S. industry in the global LCA market. Qualitative analysis was used to determine the relative influence of factors such as the Boeing-McDonnell Douglas merger and the restructuring of Airbus in Chapter 3, the emergence of Russian producers in Chapter 4, the possibility of Asian parts suppliers becoming capable of manufacturing complete airframes in Chapter 5, and the market for 500-seat aircraft and the impact of Open Skies and free flight systems on the LCA market in Chapter 6. Quantitative and qualitative analyses was used in Chapter 6 to evaluate the degree of competition that is expected to develop between LCA and 100-seat aircraft.

Overview of Competitiveness in the LCA Industry

Determinants of Competitiveness

The determinants of competitiveness, discussed in detail in Chapter 2, are the template used to conduct the qualitative analysis of the Russian LCA industry in Chapter 4 and the Asian aerospace industry in Chapter 5. These determinants represent barriers to entry for new and aspiring producers of LCA, but also serve as factors through which the globally established manufacturers, discussed in Chapter 3, compete. These determinants can be grouped into four categories: the availability of capital, industrial and demographic characteristics, corporate characteristics, and aircraft program characteristics. The extremely high level of financial investment necessary for a new aircraft program is a fundamental aspect of the global LCA industry. Manufacturers must raise large sums of capital through financial markets, direct or indirect government aid, and risk-sharing ventures designed to defer portions of costs.

The ability to raise capital must be matched by industrial and demographic characteristics of the "home" country that support the production of LCA. These characteristics include a highly skilled and educated labor force, a significant domestic market for LCA, and a manufacturing infrastructure with access to sufficient land and research and development facilities. A manufacturer's corporate characteristics determine how well it makes use of these resources. A corporate structure that encompasses flexibility, accountability, a strong credit reputation, and the ability to adjust quickly to a dynamic market is essential to establishing a global sales, marketing, and support network.

At the individual program level, an LCA manufacturer must consider its customers' costs as well as its own. Operating costs and purchase price are critical factors for airlines to assess when making acquisition decisions. For a particular aircraft purchase, airlines evaluate the total lifetime costs versus expected return using a net present value (NPV) calculation. Important determinants of the NPV are the purchase price (including financing), expected lifetime maintenance and operating costs based on the projected use of the aircraft with respect to routes and passenger load, and resale value. Aircraft characteristics that decrease operating costs are particularly important and increase the appeal of an aircraft to airlines. For example, greater commonality[7] and technological advances that improve operating efficiency both reduce operating costs.

Factors Affecting Purchasing Decisions

Operating cost has been gradually replacing technology as the primary factor that airlines use to choose LCA produced by the established manufacturers. The first indication of this shift began after the deregulation of the U.S. airline industry in 1978, when carriers began to institute significant cost reductions and require manufacturers of LCA to produce more affordable and efficient aircraft.[8] Although deregulation helped to increase aggregate sales and the efficiency of LCA manufacturers, some industry observers believe that the resulting environment has adversely affected the industry:

> ...[the] demand pull for technology has been diminished, the decline of airline engineering accelerated, progress payments from launch customers dried up, and close customer relationships and service weakened by leasing intermediaries.[9]

The LCA industry has adjusted to these changing conditions with a revised approach to competition, which is reflected by the president of Boeing's Commercial Aircraft Group noting that his company has come close to exhausting technological evolutions in its products.[10] Thus, instead of emphasizing the promotion of technological features and product support in the sale of an aircraft, LCA manufacturers now typically promote a cost-focused package of features. Any potential advantages of incorporating new technology are evaluated alongside airlines' incentives to continue using older aircraft that may be less efficient, but are already depreciated or available at very low prices.[11] The Aerospace Industries Association of America, Inc. notes that an orientation toward technological progress is still critical, but is directed more toward improving the productivity within the production process (e.g., refinements in lean manufacturing) than in incorporating technological advances in the aircraft.[12]

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[7] "Commonality" refers to the use of common features, parts, and systems across a specific manufacturer's aircraft line. Appendix E contains a glossary of industry terms used in this report.

[8] Kirkor Bozdogan, Massachusetts Institute of Technology, telephone interview by USITC staff, Dec. 22, 1997.

[9] Artemis March, *The U.S. Commercial Aircraft Industry and its Foreign Competitors* (Cambridge, MA: MIT Commission on Industrial Productivity, 1989), p. 1; see also George Eberstadt, "Government Support of the Large Commercial Aircraft Industries of Japan, Europe, and the United States," contractor document for Office of Technology Assessment, *Competing Economies: America, Europe, and the Pacific Rim* (Washington, DC: Congress of the United States, 1991), pp. 195-210.

[10] David Vadas, Aerospace Industries Association of America, Inc., telephone interview by USITC staff, Jan. 6, 1998.

[11] Artemis March, telephone interview by USITC staff, Jan. 5, 1998; and March, *The U.S. Commercial Aircraft Industry,* pp. 5-6.

[12] David Vadas, telephone interview by USITC staff, Jan. 6, 1998.

Other industry observers note that technology can be a key factor in lowering operating costs and enhancing safety,[13] which makes it a central selling component.[14] The introduction of a new aircraft offering lower operating costs through new technology may be more attractive than a lower-priced aircraft that has achieved cost reductions due to improved production efficiencies. However, since development of a new aircraft requires significant amounts of capital, there are clear cost advantages in not changing a model that has a strong sales record.

Organization of the Report

Chapter 2 provides a detailed, current discussion of the key determinants of competitiveness. Chapter 3 examines the LCA industries of the United States and Western Europe, providing background information; an analysis of the ongoing structural changes occurring in these industries, including the Boeing-McDonnell Douglas merger and the restructuring of Airbus; views of suppliers and airlines; and implications for the U.S. LCA industry. This chapter also discusses other changes in the West European LCA industry, including the development of European aircraft consortia, and presents a description of the status of the 1992 U.S.-EU Large Civil Aircraft Agreement. Implications for the competitiveness of the U.S. LCA industry are also analyzed.

Chapter 4 examines structural changes in the Russian LCA industry since the breakup of the Soviet Union, and assesses the competitive potential of Russian producers based on the determinants of competitiveness discussed in Chapter 2. Implications for the competitiveness of the U.S. LCA industry are also presented.

Chapter 5 examines the rise in Asian aerospace manufacturing ability and the efforts of Asian manufacturers to form consortia for the production of commercial aircraft--two significant global industry developments in the last 5 years. The aerospace industries of China, Korea, Indonesia, and Singapore are examined in detail, including manufacturers, products, arrangements with foreign aerospace concerns, and goals that each country has for its aerospace industry. This examination is based on the determinants of competitiveness discussed in Chapter 2. Implications for the competitiveness of the U.S. LCA industry are also presented.

Chapter 6 assesses structural changes in the global market for LCA. A discussion of new market segments analyzes the market for 100-seat aircraft, and ultra high-capacity, or 500-seat, aircraft. The effects of Open Skies agreements and the implementation of free flight systems on the demand for LCA are examined. Implications of these structural changes for the competitiveness of the U.S. LCA industry are also presented. Chapter 7 draws upon the previous six chapters to form conclusions about the effects of structural changes in the LCA industry and market since 1992 on the competitiveness of the U.S. LCA industry.

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[13] Boeing Co. official, interview by USITC staff, Seattle, WA, Feb. 12, 1998.

[14] David Mowery, Associate Professor of Business Administration, University of California at Berkeley, interview by USITC staff, Washington, DC, Dec. 9, 1997.

CHAPTER 2
KEY DETERMINANTS OF COMPETITIVENESS IN THE GLOBAL LARGE CIVIL AIRCRAFT INDUSTRY

Overview

This chapter describes important determinants of competition in the large civil aircraft (LCA) industry, and the mechanisms by which such determinants affect the ability of an aircraft producer to enter and to succeed in the global market. While access to capital is the paramount determinant of competitiveness in the global LCA market, other important determinants include a country's industrial and demographic characteristics such as design capability, manufacturing infrastructure, and the presence of a substantial domestic market. Corporate characteristics such as corporate structure and market analysis capabilities, and complex program characteristics, including arrangements with foreign aerospace entities, also determine market success.

Availability of Capital

The magnitude of the investment required to become a producer sets the highly capital-intensive LCA industry apart from other manufacturing sectors; in fact, the level of financial investment necessary to develop a new aircraft program often requires that producers effectively wager the future of the company.[15] Large sums of available capital are essential for new aircraft programs; research and development (R&D); new plant construction and facility expansions; subassembly, parts, and material procurement; and the establishment of a global after-sales support network. Such capital can be raised in financial markets, through partners in risk-sharing ventures, and via government aid. Importantly, much of the capital required is for up-front or "sunk" costs that generally cannot be recovered by selling off underlying assets.[16] Because of the nature of these investments, established producers typically enjoy a competitive advantage, as they usually have more capital to draw on from previous program successes.[17] Moreover, incumbents with a

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[15] For example, the development costs incurred by Boeing in 1966 for its 747 program are estimated to have been $1.2 billion--more than triple Boeing's total capitalization at that time. Office of Technology Assessment, *Competing Economies: America, Europe, and the Pacific Rim* (Washington, DC: Congress of the United States, 1991), pp. 15-16, as found in Laura D. Tyson and Pei-Hsiung Chin, "Industrial Policy and Trade Management in the Commercial Aircraft Industry," *Who's Bashing Whom? Trade Conflict in High-Technology Industries* (Washington, DC: Institute for International Economics, 1992), p. 167.

[16] Gellman Research Associates, Inc. for the U.S. Department of Commerce, *An Economic and Financial Review of Airbus Industrie,* Sept. 4, 1990, pp. 1-11.

[17] European aerospace industry officials, interview by USITC staff, Brussels, Mar. 31, 1998.

successful history in the industry are likely to have a higher credit rating and greater access to lower-cost commercial capital.

Financial Markets

As in other industries, the ability to raise capital in commercial markets is influenced by the financial commitments, overall financial standing, and reputation or creditworthiness of the LCA manufacturer. Raising capital in one of the world's stock and bond markets requires the company to meet certain standards, with each market setting its own requirements.[18] Typically, these requirements are a function of the company's net income, net tangible assets, and the number of shares held by those outside the company (as opposed to the number held by insiders, who generally do not trade their stock very actively).

Risk-Sharing Partnerships

The number of risk-sharing partnerships is increasing in the LCA industry. These partnerships typically exist between suppliers and LCA manufacturers, or between individual airframe manufacturers. Each partner assumes a portion of the financial risk of aircraft development and production and, in some cases, the partners may work together as a single business entity on a particular program.[19] Risk-sharing partners can fill gaps in product lines, and may assist in maintaining or achieving leadership in critical technologies.[20]

A significant benefit of risk sharing is the LCA manufacturer's ability to defer a portion of its production costs.[21] Industry sources report that a regular subcontractor recoups its nonrecurring costs up front from the LCA producer and is then paid for each unit as it delivers the components. However, a risk-sharing subcontractor prorates its fixed investment costs, such as tooling and test equipment, over an agreed-upon number of aircraft, and shares in the risk of meeting this sales goal. If the goal is exceeded, the risk-sharing subcontractor recoups its costs and earns additional profit. If the goal is not met, the risk-sharing subcontractor must absorb a portion of its nonrecurring costs.[22]

Governmental Sources

National governments can be important sources of capital in the LCA industry, and this source typically is critical to new producers because of the high barriers to entry in the industry. Overall, government financial assistance may be direct or indirect. Although the 1992 U.S.-EU Large Civil

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[18] U.S. and European aerospace industry officials, interviews by USITC staff, Seattle, London, Brussels, Bonn, Paris, and Toulouse, Feb. 10-12 and Mar. 30-Apr. 8, 1998.

[19] European aerospace industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[20] Artemis March, *The U.S. Commercial Aircraft Industry and its Foreign Competitors* (Cambridge, MA: MIT Commission on Industrial Productivity, 1989), p. 44.

[21] European aerospace industry officials, interview by USITC staff, London, Mar. 30, 1998.

[22] John F. Hayden, corporate vice president, Washington, DC, operations of The Boeing Co., hearing testimony in connection with USITC investigation No. 332-332, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft*, Apr. 15, 1993.

Aircraft Agreement placed limits on the amount of direct and indirect support governments could provide for aircraft programs, there remains considerable disagreement within and outside the industry about the definitions of allowable government assistance.[23]

Direct Government Support

The most open means of government financial assistance is direct support through outright grants, "soft" loans,[24] or programs targeted specifically toward a particular industry. Many argue that a principal factor in the rise of the Airbus consortium was the funding made available to the consortium by its member countries' governments.[25] Aside from receiving government conditional repayment loans at below-market rates with deferred interest, Airbus partners also have received government-guaranteed loans made by private lending institutions.[26]

Direct government support may also take the form of aeronautical R&D–funded by or performed at government facilities–that contributes directly to LCA programs. Government-funded research programs generally tend to be long-term ventures that are not oriented toward specific products and not crucial to short-term projects.[27] Government-funded R&D in the aerospace field can defray significant costs by providing manufacturers with the opportunity to gain direct experience with, or to share knowledge about, new technologies and processes. However, cooperation and coordination must exist between various government-run and commercial projects for this benefit to be realized.

Indirect Government Support

Benefits that accrue indirectly to an industry as a result of incentives designed for other industries are considered indirect supports. These types of support are the subject of much discussion in both the United States and the European Union (EU), as each has a different position regarding the amount of "crossover benefit" that defense aeronautical manufacturing and R&D contributes to the competitiveness of the civil aircraft industry.[28] While the aforementioned 1992 Agreement reached between the United States and the EU addressed the issue of indirect supports, industry officials have indicated that a major continuing issue of contention is a comprehensive definition of what types of aid constitute indirect supports.[29]

[23] See Chapter 3 for status of the Agreement and Appendix E for signatories' views.

[24] "Soft" loans may be construed as those with below-market requirements, either through lower, preferential interest rates or unusual terms of repayment, or a combination of both.

[25] European aerospace industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[26] Virginia C. Lopez and David H. Vadas, *The U.S. Aerospace Industry in the 1990s: A Global Perspective* (Washington, DC: The Aerospace Research Center, Aerospace Industries Association of America, Inc., Sept. 1991), p. 54.

[27] European aerospace industry officials, interview by USITC staff, Brussels, Mar. 31, 1998.

[28] Boeing officials, interview by USITC staff, Seattle, WA, Feb. 10-12, 1998; and European industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[29] European aerospace industry officials, interviews by USITC staff, Brussels and Paris, Mar. 31 and Apr. 3, 1998.

Industrial and Demographic Characteristics

The industrial and demographic characteristics of a country that facilitate the development of a competitive LCA manufacturer include comprehensive design capabilities and establishments that are sufficiently integrated with manufacturing processes and facilities; and a sophisticated transportation, aeronautical testing, and manufacturing infrastructure complemented by an educated labor force. Also important is the presence or likelihood of a large domestic market for LCA.

Design Capabilities

Aircraft design capability, which includes the ability to integrate the many complex systems necessary for flight, is developed over time with large amounts of capital, R&D, and labor. Although it may be possible to purchase the necessary components needed to imitate successful aircraft production, the experience needed to create an original design and transform it into a globally acceptable aircraft is not easily gained. Moreover, while the design phase of a new program may be lengthy, once a decision has been made to introduce a new aircraft, the finished product must be brought to market rapidly. The management and production expertise necessary to effectively manage the design phase and the transition from the design to the production phase has a substantial impact on competitiveness.[30]

Established LCA manufacturers do not readily share such critical knowledge about technology and design capability.[31] However, established manufacturers may be persuaded to share limited amounts of technology and design information with aspiring producers because of factors such as low costs of production in the new producer's country, the inability of the established entity to respond to a particular market niche alone, or as a precondition to market access.[32]

Manufacturing Infrastructure

A manufacturing infrastructure capable of supporting LCA production must have access to, or include, elements such as a skilled and highly educated labor force; aeronautical R&D facilities; aerospace manufacturing facilities and equipment, including an airfield for testing and aircraft delivery; and access to basic aircraft components such as aircraft-quality aluminum, steel, wire, cable, and fasteners. The requisite amounts of land can be a barrier to LCA manufacture in densely populated countries; a large-scale LCA manufacturing site includes huge production facilities equipped with sophisticated, computerized tooling; one or more runways; and rail, ship, and/or truck access for parts receiving.[33]

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[30] David C. Mowery, *Alliance Politics and Economics: Multinational Joint Ventures in Commercial Aircraft* (Cambridge, MA: American Enterprise Institute, Bollinger Publishing Co., 1987), pp. 32-33.

[31] U.S. and European aerospace industry officials, interviews by USITC staff, Seattle, London, Brussels, Bonn, Paris, and Toulouse, Feb. 10-12 and Mar. 30-Apr. 8, 1998.

[32] Asian aerospace industry officials, interviews by USITC staff, Seoul and Beijing, Apr. 27-May 8, 1998.

[33] Boeing officials, interviews by USITC staff, Seattle, WA, Feb. 10-12, 1998, and Airbus officials, interview by USITC staff, Toulouse, France, Apr. 6-7, 1998.

Any manufacturer of complex machinery must have a pool of skilled labor available. Moreover, a country wishing to establish and promote LCA manufacturing must have access to a sophisticated academic system capable of producing highly educated engineers. This is especially important for LCA manufacturers who wish to produce globally acceptable aircraft for developed airline markets. These producers are required to build products that meet the strict international standards adopted by most developed nations.

LCA manufacturers also require access to aircraft design tools such as supercomputers and software for computational fluid dynamics (CFD), wind tunnels, and prototype aircraft for flight demonstrations and technology validation. CFD and wind tunnels play crucial roles in aircraft design by reducing development time and required hours of flight testing, thus allowing LCA producers to investigate a greater number of design options over a shorter period of time.[34] An LCA producer also requires continued wind tunnel and computer upgrades to keep abreast of new technological developments in aeronautics and aerodynamics.

Because of the increasingly global nature of the LCA industry, the availability of domestic airframe subcontractors and parts suppliers is decreasing in importance.[35] For current WTO signatories, most impediments to trade in civil aircraft and parts were eliminated in the General Agreement on Tariffs and Trade (GATT) Agreement on Trade in Civil Aircraft in the Trade Agreements Act of 1979, prompting a dramatic increase in cross-border subcontracting and component sourcing. Moreover, foreign components generally can be obtained on a risk-sharing basis, with foreign suppliers gaining market access in return for assuming additional development risk.

Industry officials have indicated that though it is important to maintain a domestic supplier base for reasons such as national security or exchange rate risk, LCA manufacturers generally look globally for high-quality, competitively priced parts suppliers.[36] The global nature of the LCA industry is illustrated by the trend of foreign content in LCA. Boeing reports that, excluding engines, the foreign content of the 727 (launched in 1959) was at most 2 percent;[37] the foreign content of the 767 (launched in 1978) varies between 10 and 26 percent;[38] and the foreign content of the 777 (launched in 1990) ranges between 15 to 29 percent, for an aircraft with U.S. or foreign engines, respectively.[39] Moreover, Airbus reports that foreign content (principally U.S.), including engines, accounts for 30 percent of the A310-300; 17 percent of the A320; 30 percent of the A330-300 with U.S. engines, and 10 percent with British engines.[40]

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[34] For more information, see U.S. International Trade Commission, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft* (investigation No. 332-332), USITC publication 2667, Aug. 1993, p. 6-1.

[35] European aerospace industry officials, interviews by USITC staff, Brussels and Paris, Mar. 31, and Apr. 3, 1998.

[36] European aerospace industry officials, interview by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[37] Jonathan C. Menes, acting secretary for trade development, posthearing submission on behalf of the U.S. Department of Commerce in connection with USITC investigation No. 332-332, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft (1993)*, p. 10.

[38] John F. Hayden, Boeing Co., posthearing submission, USITC investigation No. 332-332.

[39] Boeing official, e-mail communication to USITC staff, July 27, 1998.

[40] Renee Martin-Nagle, corporate counsel, Airbus Industrie North America, Inc., posthearing submission, USITC investigation No. 332-332, p. 2.

Domestic Market Conditions

The presence or likelihood of a large domestic market for LCA is a competitive strength for existing and potential LCA manufacturers.[41] Large markets allow producers to take advantage of economies of scale in production,[42] while strong domestic airlines can act as launch customers for aspiring producers,[43] demonstrating the reliability and value of an aircraft before the company establishes the credibility and support network necessary for export. Boeing and Airbus each have access to large domestic markets in the United States and the EU, respectively. Countries such as Singapore and Korea note the small size of their respective domestic markets as a weakness in the development of a domestic LCA industry, and stress the need for foreign partners to gain access to foreign markets. The relatively large Chinese market is viewed as a strength for potential producers in that country.[44]

Corporate Characteristics

The corporate characteristics necessary for an LCA manufacturer to be competitive include a flexible, accountable, creditworthy, and dynamic corporate structure. Also critical to competitiveness are comprehensive capabilities to assess and respond to changes in demand and develop new products for markets.

Corporate Structure

Corporate structure has a notable effect on competitiveness in the global LCA industry. For example, corporate structure determines the level of access to capital and influences the internal decision-making process. Not all companies in the LCA industry fit neatly into one category of corporate structure; some share the characteristics of privately held corporations, publicly held corporations, and government-run companies.[45]

Access to capital is potentially greater under certain forms of corporate structure. Publicly held corporations typically have more options for raising lower-cost capital than privately held corporations, as the mandated financial information available to potential investors and standards for reporting and management imposed by stock market regulatory agencies have the effect of

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[41] European airline official, interview by USITC staff, London, May 22, 1998.

[42] Korea Institute for Industrial Economics and Trade official, interview by USITC staff, Seoul, Apr. 27, 1998.

[43] Historically, Airbus' primary launch customers have been core European airlines, while Boeing's launch customers have been U.S. airlines. European airline officials, interviews by USITC staff, London and Paris, Mar. 30 and Apr. 2, 1998.

[44] Asian LCA industry officials, interviews by USITC staff, Seoul, Apr. 27 and May 1, and Jakarta, May 13, 1998.

[45] A publicly held corporation is traded on a stock market and must meet the attendant obligations of authoritative bodies such as the U.S. Securities and Exchange Commission, while a privately held corporation need not make its financial or operational data available to the general public. Government-run companies are those that are largely controlled by a government even if the government does not maintain majority ownership.

lowering investor and lender uncertainty.[46] Lower uncertainty, or lower risk, typically confers on a firm the benefits of lower interest rates and a greater array of financing options. Generally, risk is higher for a privately held corporation, effectively raising the cost of capital. A privately held corporation also does not have access to as wide a variety of debt instruments and equity financing as does a publicly held corporation.

A government-run organization may or may not have access to such funds, but such a company is in the position to access government funds and/or loans with favorable terms which the company would not be able to secure from unrelated financial markets.[47] Enhanced awareness of, and access to, relevant government R&D can be another benefit of this type of corporate structure.[48]

The speed of the decision-making process in a corporation can affect flexibility and response time, both crucial to success in a dynamic market. Centralized decision making can improve response time and allow a company to move quickly and decisively when faced with new market opportunities.[49] Clearly defined accountability within the process can lead to less uncertainty and a greater focus on solving problems in a timely manner, which is a benefit to operational efficiency. While these results are likely in both publicly held and privately held corporations, certain publicly held corporations suffer one disadvantage that many privately held corporations do not. Publicly held corporations are obligated to make business decisions at the behest of their stockholders who tend to focus on short-term results,[50] which can be a disadvantage in an industry characterized by significant, long-term, strategic investments.[51] The more concentrated ownership structure of a privately held corporation can alleviate this conflict between stockholder goals and management goals. Government-run companies face another type of challenge in the decision-making process when burdened by layers of bureaucracy that can slow response and program development time. Moreover, it is possible that decisions will be slowed by conflicting sources of authority and accountability, or will be based on political considerations, rather than the best interests of the company or the aircraft programs.[52]

Finally, corporate structure determines whether a firm must report financial results or pay taxes on profits. For example, a *groupement d'intérêt économique* (G.I.E.) under French law is not required to pay taxes on its profits unless it so elects.[53] Airbus is one of the companies that has this type of French corporate structure.

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[46] U.S. and European aerospace industry officials, interviews by USITC staff, Seattle, London, Brussels, Bonn, Paris, and Toulouse, Feb. 10-12 and Mar. 30-Apr. 8, 1998.

[47] Ibid.

[48] See the section of this chapter entitled "Indirect Government Support."

[49] U.S. and European aerospace industry officials, interviews by USITC staff, Seattle, London, Brussels, Bonn, Paris, and Toulouse, Feb. 10-12 and Mar. 30-Apr. 8, 1998.

[50] For more information, see USITC investigation No. 332-332, p. 4-2.

[51] In the LCA industry, factors such as the traditional business cycle of aircraft orders and time frames for new product introduction may also significantly influence the decision process.

[52] European aerospace industry officials, interviews by USITC staff, Paris, Apr. 2-3, 1998.

[53] Gellman Research Associates, *An Economic and Financial Review of Airbus Industrie*, p. 1-2; and George Eberstadt, "Government Support of the Large Commercial Aircraft Industries of Japan, Europe, and the United States," contractor document for Office of Technology Assessment, *Competing Economies: America, Europe, and the Pacific Rim* (Washington, DC: Congress of the United States, 1991), p. 236.

Market Analysis Capabilities

Market analysis capabilities allow an LCA manufacturer to develop new aircraft or increase the production of specific types of aircraft in response to predicted market demand. As noted earlier, capital investments in aircraft development are large and irreversible. Therefore, any new program must be carefully evaluated before its initiation to weigh the costs of producing the aircraft against the anticipated demand for the aircraft and resulting return on investment. To launch a new aircraft successfully, the manufacturer attempts to identify an area of growing demand that is not well served by its own or its competitors' models.[54] Firm strategy, derived from market analysis, is a critical component in the ability to develop market share and profitability.

Market analysis is also critical so that manufacturers can respond to changes in the levels of demand for the various types of aircraft they offer. The numerous factors that affect market demand include structural changes in the market for LCA; such changes can simultaneously affect both total demand for aircraft and demand for particular types of aircraft.[55] Without in-depth market analysis capabilities, it is more difficult to respond to shifting demand across aircraft types.

Program Characteristics

An LCA producer must be keenly responsive to the market factors that will determine the success of its program(s). Manufacturers that can respond rapidly to changes in demand by incorporating necessary adjustments into their aircraft programs have a clear competitive advantage. The most important facets of market appeal for LCA that producers need to take into account include competitive purchase prices and operating costs, commonality with other aircraft types, the existence of a global support network, and aircraft certification to international standards.[56]

Purchase Price and Operating Costs

When an airline or leasing company decides to purchase an aircraft, the net present value (NPV)--a discounted cash flow calculation--is the paramount determinant. Primary variables used to calculate the NPV include the purchase price of the aircraft and the aircraft's operating costs.[57] Reportedly, the acquisition cost of a new aircraft is now approximately 30-40 percent of its lifetime direct operating costs. As a result of the increasing importance of operating costs as a component, airlines are focusing more on controlling these costs, and mid-life maintenance costs

[54] Because the potential market for a specific new LCA product can be limited, the firm that makes a successful "first move" typically garners the largest share of the new market. Aggressive pricing at this stage to gain market share can further enhance a firm's competitive position.

[55] See chapter 6 for specific information on changes in the market for LCA. For example, deregulation increased the demand for smaller aircraft relative to other types, and also increased the total demand for aircraft by lowering airfares and increasing the demand for air travel. European aerospace industry officials, interview by USITC staff, London, Mar. 30, 1998.

[56] For more information, see USITC investigation No. 332-332, p. 4-7.

[57] Operating costs comprise many inputs, including employee salaries, fuel, and maintenance costs.

in particular, rather than other aircraft operating cost components over which the airline has less control.[58]

Industry sources generally agree that one of the decisive factors contributing to LCA manufacturers' competitiveness is the direct operating costs of their aircraft. Particularly since deregulation, U.S. airlines are less eager to introduce new aircraft into their fleets that do not offer significant improvements in seat-mile operating costs.[59] However, it is now more difficult for airframe manufacturers to make more than incremental improvements in direct operating costs, partially because the decline in fuel prices from the high levels of the early 1980s has limited the benefits to be had from technological improvements in fuel consumption rates.

Changes in product characteristics are driven by the market and/or public mandates regarding safety and environmental standards. However, when designing a new aircraft, the LCA manufacturer must weigh the cost of incorporating new technologies against the cost savings the aircraft will realize. In other words, manufacturers use demonstrable cost-effectiveness as their guide in evaluating whether to develop and apply new technologies. Improvements in product characteristics usually fall within the following categories: (1) improved operating costs of an aircraft (e.g., lower fuel burn, weight, and maintenance costs); (2) improved environmental performance (e.g., noise, emissions, and materials and manufacturing processes); and (3) improved passenger appeal (e.g., ride comfort, interior environment, ease of deplaning and boarding, and internal noise level).[60]

Commonality with Other Aircraft

Commonality refers to the use of common features, parts, and systems in an LCA manufacturer's aircraft that enables an airline to operate as homogeneous a fleet as possible. The benefits of commonality accrue both to airlines and to LCA manufacturers. Development cost efficiencies are the primary benefit to manufacturers. By using common features and parts on different planes, manufacturers spread development costs across more products. Moreover, the cost of developing a derivative with common features is significantly cheaper than that of developing an entirely new aircraft. For example, one estimate indicates that the incremental costs of stretching an airframe rarely exceed 25 percent of the original development costs.[61] Common parts and manufacturing requirements also allow for efficient assembly of different aircraft on the same production line and provide for increased productivity through the use of common production techniques.

[58] European airline official, interview by USITC staff, London, May 22, 1998.

[59] The airline's cost to transport one seat (occupied or not) one mile.

[60] European airline official, interview by USITC staff, London, May 22, 1998.

[61] Mowery, *Alliance Politics and Economics*, p. 33. The ability to alter the length of the aircraft, thereby altering its capacity, is a critical consideration in aircraft design. It is far less expensive to change the length of the fuselage than to change the aircraft wing design. An aircraft wing design dictates its ultimate lifting capacity and speed; therefore, a manufacturer ideally designs its wings for both current and projected lift demands/aircraft programs.

It is beneficial for LCA manufacturers to employ commonality both among members of their aircraft families[62] and across their entire product lines,[63] thereby providing airlines with an incentive to choose products from other families of the same manufacturer. In other words, it encourages fleet-wide, not just family-wide, commonality. However, commonality does have a drawback for manufacturers. Because it bases an entire range of aircraft on constantly-aging technology, manufacturers must continually assess the economic trade-offs between maintaining a certain level of commonality and introducing new technology.

Some of the benefits of commonality for airlines accrue from reduced parts and tool inventories, reduced pilot and mechanic training, and simplified work procedures for ground maintenance staff, allowing quicker aircraft turnaround at the gate. Design commonality enables easier cross-training of pilots for more than one aircraft. Time and costs are reduced when pilots need only take supplemental training as opposed to entirely new training for a different aircraft type.[64] Cross-training is also advantageous to airlines because it increases scheduling flexibility for flight crews. All of these factors contribute to lower the ultimate cost of an aircraft.

Commonality also tends to discourage entry by new manufacturers. For example, Russian LCA producers have stated that to sell in Western markets, they must use Western engines and avionics, not just because of quality considerations, but also because of commonality.[65] In the past, industry sources reported that airlines typically would not consider breaking their fleet's commonality unless a new aircraft could provide at least a 10-percent cost savings over their existing fleet, typically through the inclusion of new technology.[66] However, airlines have recently noted that the benefits of commonality may have been overstated.[67] This perception may have changed with the emergence of a duopoly in the market, and airlines' resulting desire to maintain two competitive aircraft producers.[68]

Global Support Network

After-sales support and personnel training are extremely important competitive marketing tools for LCA manufacturers. Industry officials have acknowledged that offering competitive product support is as important as having a successful aircraft design.[69] Although the up-front costs involved in establishing and maintaining a satisfactory and competitive after-sales support network are substantial, economies of scale can be significant since the cost-per-plane of providing such

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[62] An aircraft family is comprised of several variations of one model, e.g., the 737 series includes the 737-100 through the 737-900. Airbus also has such families of aircraft.

[63] A product line refers to the entire range of product each LCA manufacturer offers.

[64] Airbus Industrie officials, interview by USITC staff, Toulouse, France, Apr. 6, 1998.

[65] Russian aircraft would have these advantages if they shared the same engines with other non-Russian LCA. Russian aerospace industry officials, interviews by USITC staff, Moscow, Mar. 26-Apr. 3, 1998.

[66] European airline official, interview by USITC staff, London, May 22, 1998.

[67] Ibid.

[68] Compiled from responses to USITC airline questionnaires.

[69] John E. Steiner, "How Decisions Are Made: Major Considerations for Aircraft Programs," speech delivered before International Council of the Aeronautical Sciences, American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, WA, Aug. 24, 1982, p. 32.

support declines considerably as market share increases.[70] The most important measure of the quality of an LCA manufacturer's product support is its ability to rapidly service a disabled aircraft, commonly referred to as an aircraft on the ground (AOG). Because of the significant opportunity costs incurred by an airline when it has an AOG, airlines demand immediate global AOG service.[71] To meet this demand, aircraft manufacturers have strategically placed global parts depots and factory representatives in many airports around the world should an airline need specific product information.[72] The cost to maintain this global network is a formidable but necessary part of product support. Product support also entails the training of flight crews and airline maintenance engineers; operations engineering support; after-sales support; routine maintenance and ground operations; and establishment of an educational program for the airlines to determine the tools, facilities, test equipment, and spare parts inventory they should maintain.[73]

Certification of Aircraft

For an aspiring LCA producer, the ability to produce an aircraft that meets global safety and noise standards and can therefore be certified by Western aviation authorities is a formidable task, both technologically and financially.[74] The U.S. Federal Aviation Act requires that LCA registered in the United States, whether produced in the United States or imported, have their designs certified as safe by the U.S. Federal Aviation Administration (FAA).[75] West European regulators also coordinate aircraft certification activities through a single organization, the Joint Aviation Authorities (JAA),[76] that has developed its own standards and practices since 1970.[77] In addition to the FAA and JAA, there are a multitude of airworthiness authorities in various countries around the world that primarily follow the standards and requirements promulgated by the FAA or JAA.[78] As a result, any new entrant must meet these standards if it wishes to ensure global acceptance of its product, and have access to the significant U.S. or West European aircraft markets.

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[70] Gellman, *An Economic and Financial Review,* p. A-8.

[71] Opportunity costs are incurred because the aircraft cannot be flown until it is repaired.

[72] Airbus Industrie and Aero International (Regional) officials, interviews by USITC staff, Toulouse, France, Apr. 6-8, 1998.

[73] March, *The U.S. Commercial Aircraft Industry,* p. 29.

[74] This process may cost several million dollars and take several years to complete. Airbus Industrie official, interview by USITC staff, Toulouse, Apr. 6, 1998.

[75] 14 C.F.R. pt. 25.

[76] However, certificates of airworthiness and the certification process itself still come under the purview of Western Europe's national civil aviation authorities. Commission of the European Communities, *A Competitive European Aeronautical Industry (Communication from the Commission)* (Brussels: Commission of the European Communities, SEC (90) 1456 final, July 23, 1990), p. 11.

[77] U.S. General Accounting Office (GAO), *Aircraft Certification: Limited Progress on Developing International Design Standards* (Washington, DC: GAO, Aug. 1992), p. 2. JAA membership now includes the authorities of 26 countries - the EU states, Cyprus, the Czech Republic, Hungary, Iceland, Malta, Monaco, Norway, Poland, Slovenia, Switzerland, and Turkey. A recent EC regulation required all EC countries to join JAA, adopt all of JAA's Joint Airworthiness Requirements, and accept imported products certified by JAA without additional technical conditions. Europa, found at Internet address http://europa.eu.int/en/comm/dg07/press/ip961157.htm#1, retrieved Dec. 30, 1997.

[78] Boeing officials, interviews by USITC staff, Seattle, WA, Feb. 10-12, 1998.

Industry consensus indicates that a common set of international standards and practices would benefit both LCA manufacturers and airlines by eliminating differences and duplication of certification standards and practices.[79] Minor differences in FAA and JAA regulations and interpretations can necessitate significant cost commitments and cause delays and overruns in production schedules for established LCA manufacturers.[80] These adverse effects may be compounded for the new entrant, given the lack of experience it might have in dealing with and complying with such regulations.

Arrangements with Foreign Aerospace Entities

Because substantial experience is necessary to create and transform an original design into a commercially successful aircraft, and to cope with the attendant marketing considerations, a company without prior experience in the LCA industry is likely to partner with an existing producer. An arrangement with an established aerospace entity can provide the competitive elements that the aspiring producer is unlikely to possess, including knowledge regarding critical technologies, design capability, and market analysis capabilities. In addition, these can benefit the aspiring producer by providing an established global network for marketing, sales, and after-sales support. Consequently, arrangements with established aerospace manufacturers confer to aspiring producers some of the public confidence in products and product-support that established manufacturers enjoy. In return, the established producer may gain access to new and developing markets.

Summary

The determinants of competition described in this chapter represent both barriers to entry as well as factors through which established manufacturers compete. As such, these determinants must be satisfied at a minimal level before aircraft from a manufacturer are seriously considered by purchasers in the market. For new and aspiring producers, the determinants largely represent barriers to entry into the industry. The established LCA producers, Boeing and Airbus, have already met basic criteria such as infrastructure requirements, and compete based on their relative ability to satisfy more qualitative aspects of these competitive determinants.

[79] "Responses of Airbus Industrie, G.I.E. to Questions Regarding the ITC's Study on Global Competitiveness of the U.S. Aircraft Industry," tab K; and submission from the Aerospace Industries Association of America, Inc., in connection with USITC investigation No. 332-332, p. 17.

[80] Boeing officials, interviews by USITC staff, Seattle, WA, Feb. 10-12, 1998, and Airbus Industrie officials, interview by USITC staff, Toulouse, France, Apr. 6-7, 1998.

CHAPTER 3
CHANGES IN THE STRUCTURE OF THE U.S. AND WEST EUROPEAN LARGE CIVIL AIRCRAFT INDUSTRIES

Overview

The merger of The Boeing Co. (Boeing) and McDonnell Douglas Corp. (McDonnell Douglas) fundamentally altered the dynamics of the global large civil aircraft (LCA) market by creating a duopoly characterized by heightened price competition.[81] In response to value-driven airline purchasing decisions, aircraft pricing is currently performing like that of substitutable commodities rather than that of customized products incorporating a high technology level. As a result, aircraft technology is presently focused on manufacturing cost improvements, regulatory compliance, and life-cycle cost reductions, with less emphasis on innovative aircraft technologies.[82]

As Boeing and Airbus Industrie, G.I.E. (Airbus) sacrifice historical price and profit levels to gain or maintain market share, they are aggressively pursuing cost reductions by implementing internal cost-saving measures; demanding cost reductions from suppliers; cutting the number of suppliers; increasing their level of outsourcing; and shifting greater design and manufacturing responsibility and risk to their larger, more diversified subassembly and parts producers. With the U.S. supplier industry already in the midst of major restructuring, the likely net effect of these changes will be a more concentrated aerospace industry.

The structural changes in the global aerospace industry have roots in events of the late 1980s and early 1990s. The economic and political repercussions of the Gulf War, relaxation of Cold War tensions, and global recession, coupled with poor airline financial performances and a decline in the availability of capital to finance new aircraft purchases, helped to depress total demand for military and commercial aircraft, leading to adverse production, labor, and financial consequences for the industry. In the civil sector, large volume aircraft orders placed by the airlines during the

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[81] See, for example, Richard Aboulafia of the Teal Group, "Uncertain Upturn Challenges Commercial Transport Makers," Aviation Week Group, found at Internet address http://awgnet.com/aviation/
sourcebook/sbtrans.htm, retrieved Sept. 11, 1997; Ronald Henkoff, "Boeing's Big Problem," *Fortune*, Jan. 12, 1998, found at Internet address http://pathfinder.com/fortune/1998/980112/boe.html, retrieved Jan. 8, 1998; Frederic M. Biddle and John Helyar, "Fearing a Loss of Its Market Share, Boeing Took Orders It Couldn't Fill," *The Wall Street Journal*, Apr. 24, 1998, The PointCast Network; and U.S. Securities and Exchange Commission (SEC), Boeing's Form 10-K Annual Report for Fiscal Year 1997, found at Internet address
http://www.sec.gov/Archives/edgar/data/12927/0000012927-98-000007.txt.

[82] European airline official, interview with USITC staff, London, May 22, 1998, and U.S. LCA supplier industry official, telephone interview with USITC staff, Aug. 5, 1998.

boom of the mid- to late-1980s were mostly filled by 1990, and in the early 1990s production rates sagged (table 3-1). This slump coincided with financial losses recorded by the global airline industry during 1990-92, and a glut of new and used aircraft on the market that depressed aircraft prices. With strong aircraft price competition, an improvement in airlines' financial performance since 1993, and the introduction of several new aircraft in recent years, LCA orders have likely reached the peak of the cycle, leading to anticipated production growth for the rest of the decade.

In response to the cyclical fluctuations of the aerospace business, a number of aerospace firms have pursued mergers, acquisitions, and other alliances to maintain or increase market share; reduce costs; broaden product scope; and share the risks of program development, manufacturing, and follow-on production activities to strengthen their position in the sector and improve their financial outlook. Other aerospace firms, such as Fokker, closed their doors or discontinued product lines during this turbulent period. Although much of the acquisition activity has occurred among U.S. corporations, the pace of restructuring in the European aerospace industry is accelerating as national governments and aerospace firms increasingly proclaim the need to integrate defense and commercial aerospace sectors to better compete with their U.S. counterparts.[83]

Table 3-1
Global LCA net orders and deliveries, by manufacturer, 1992-97

Manufacturer	1992	1993	1994	1995	1996	1997
	LCA net orders					
Boeing	234	209	109	338	712	551
Airbus	123	35	115	103	314	459
McDonnell Douglas	43	16	13	130	45	17
Other[1]	30	42	36	60	21	27
Total	430	302	273	631	1,092	1,054
	LCA deliveries					
Boeing	441	330	270	206	220	321
Airbus	157	139	123	123	126	182
McDonnell Douglas	127	79	40	50	51	54
Other[1]	59	82	61	37	30	21
Total	784	620	494	416	427	578

[1] Includes the Fokker 100 and all British Aerospace 146 and RJ aircraft models, including those under 100 seats.

Source: *World Jet Inventory Year-End 1997*, Jet Information Services, Inc., Mar. 1998, p. 14.

[83] Dr. Norbert Lammert, "Europe Needs An Integrated Aerospace Industry," Flug Revue Online, Oct. 1997, found at Internet address http://www.flug-revue.rotor.com/FRheft/FRH9710/FR9710c.htm, retrieved Oct. 8, 1997; and John D. Morrocco, "EC Outlines Path for Consolidation," *Aviation Week & Space Technology*, Oct. 6, 1997, p. 24.

The Boeing Co.

The Boeing-McDonnell Douglas merger,[84] announced on December 15, 1996, had obvious benefits for Boeing, which had been seeking a partner with a large defense capability to complement its existing product ranges and to better position itself in the consolidating defense industry. McDonnell Douglas, on the other hand, was in poor financial condition as a result of a soft defense market and key program losses, as well as declining customer confidence[85] and intense competition in its commercial aircraft business.

Pre-Merger Company Profiles

Although both Boeing and McDonnell Douglas were major players in the world aerospace industry prior to their merger, the two companies had strong positions in different segments of the market. Pre-merger Boeing, with sales of $22.7 billion in 1996,[86] was the world's second-largest aerospace company after Lockheed Martin, a major defense contractor.[87] The Boeing Commercial Airplane Group, the firm's civil aircraft division, was the world's largest producer of commercial aircraft, consistently accounting for more than 70 percent of Boeing's annual sales during 1992-96.[88] With its established program success record, Boeing demonstrated considerable strength in such areas as product quality, engineering, and customer support,[89] and was particularly adept at broadening its product range and customer base with the development of derivative aircraft.[90] Because of its corporate culture and dominant position in the industry, however, Boeing had also become somewhat insular, narrowly focused, and resistant to change.[91] Furthermore, the firm was slow to make critical cost improvements in its business and manufacturing processes and develop strategies to better manage the boom/bust LCA business cycle. Following its acquisition of most of Rockwell International Corp.'s aerospace and defense businesses in December 1996, Boeing was also a leading U.S. supplier of defense-related equipment. However, the company was still

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[84] The merger was a stock-for-stock transaction valued at $13.3 billion. "McDonnell Douglas to Merge with Boeing," Boeing news release, Dec. 15, 1996, found at Internet address http://www.boeing.com/
news/releases/mdc/961215.html, retrieved Aug. 25, 1997.

[85] U.S. SEC, McDonnell Douglas Form 10-K Annual Report for Fiscal Year 1996, found at Internet address http://www.sec.gov/Archives/edgar/data/63917/0000063917-97-000005.txt.

[86] U.S. SEC, Boeing Form 10-K Annual Report for Fiscal Year 1996, found at Internet address http://www.sec.gov/Archives/edgar/data/12927/0000012927-97-000020.txt.

[87] Kevin O'Toole, "Only the Beginning," *Flight International*, Aug. 20-26, 1997, p. 30.

[88] Sales of commercial aircraft accounted for approximately 73 percent ($16.9 billion) of Boeing's total revenues in 1996. U.S. SEC, Boeing Form 10-K Annual Report for Fiscal Year 1996.

[89] Stanley Holmes, "European Airline Executives Blast Boeing Production Problems," *The Seattle Times*, Mar. 27, 1998, found at Internet address http://newsedge, retrieved Apr. 20, 1998; and "Boeing Positioned Well for the Future, Woodard Says," PR Newswire, Mar. 10, 1998, found at Internet address http://newsedge, retrieved Mar. 11, 1998.

[90] Polly Lane, "Boeing Plans New Twists on Old Frames," *The Seattle Times*, Aug. 25, 1997, found at Internet address http://newsedge, retrieved Aug. 26, 1997.

[91] "Boeing President Sees Greatest Challenge Coming from Within the Company," *The News Tribune*, Mar. 27, 1998, found at Internet address http://newsedge, retrieved Apr. 20, 1998.

in the market for additional military acquisitions to increase its defense presence and help offset the cyclical nature of its LCA business.

McDonnell Douglas, on the other hand, was the world's leading military aircraft manufacturer[92] and third-largest aerospace company,[93] with sales of $13.8 billion in 1996. Defense operations were traditionally the largest contributors to McDonnell Douglas's revenues, accounting for 74 percent of company revenues in 1996.[94] McDonnell Douglas's ability to compete successfully in the civil aircraft market and generate additional aircraft orders was premised on its role as a niche player.[95] The company's narrow product line and limited commonality,[96] however, worked to its disadvantage when marketing its aircraft to airlines seeking a wide range of complementary aircraft. Moreover, McDonnell Douglas's failure to make necessary investments to bolster the competitiveness of its product range contributed to the appearance that the company had lost its commitment to the market.[97] According to some industry analysts, McDonnell Douglas's low risk, low investment approach to its commercial aircraft production determined its fate.[98]

Merger Background

Boeing has emerged as the world's largest aerospace company and one of the leading U.S. military contractors as a result of the merger with McDonnell Douglas and its earlier acquisition of Rockwell's defense and space businesses. These additions boosted Boeing's sales to $45.8 billion in 1997,[99] and contributed to the balancing of Boeing's civil and military operations. The share of company sales represented by commercial aircraft operations dropped to 59 percent in 1997, as sales of information, space, and defense systems rose to 40 percent.[100]

Although the merger of these two companies was approved by the U.S. Federal Trade Commission on July 1, 1997, the deal was subject to considerable trans-Atlantic dispute and negotiation during the period when the European Commission (EC) conducted its own merger review. During the course of the 4-month investigation that began in March 1997, the EC raised several objections to the merger,[101] claiming that it would reduce opportunities in the near term for potential competitors (i.e., Airbus) in the LCA market. After weeks of negotiations, the merger was formally approved on July 30, 1997, when Boeing and the EC struck an agreement on a package

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[92] Michael Skapinker, "$1.4bn Charge to Put Boeing in Red," *Financial Times*, Jan. 22, 1998, p. 16.

[93] O'Toole, "Only the Beginning."

[94] U.S. SEC, McDonnell Douglas Form 10-K Annual Report for Fiscal Year 1996.

[95] Ibid.

[96] Mark Egan, "Boeing Unveils Newest Jet for Regional Carriers," Reuters Ltd., June 10, 1998, The PointCast Network. For a discussion of commonality, see Chapter 2.

[97] Airbus Industrie, G.I.E. official, interview by USITC staff, Toulouse, France, Apr. 6, 1998.

[98] "Requiem for a Heavyweight," *Air Transport World*, Sept. 1997, p. 128.

[99] U.S. SEC, Boeing Form 10-K Annual Report for Fiscal Year 1997.

[100] Service and other miscellaneous operations account for the remainder of company sales. Boeing Form 10-K Annual Report for Fiscal Year 1997.

[101] The three main objections were that 1) Boeing would have a dominant position in the global civil aircraft market to the detriment of Airbus's competitive position; 2) U.S. Government defense funds for military research could be used to support Boeing's commercial aircraft programs; and 3) Boeing's recently concluded exclusive supply arrangements with American Airlines, Continental Airlines, and Delta Air Lines for a 20-year period would limit access for other LCA suppliers. "Peace in Our Time," *The Economist*, July 26, 1997, pp. 59-61.

of merger modifications.[102] The Boeing-McDonnell Douglas merger became effective on August 1, 1997; joint operations began on August 4, 1997.

Products

As the world's largest LCA producer with a vast commercial aircraft product line, Boeing had little interest in the relatively limited range of the McDonnell Douglas civil aircraft group.[103] Boeing's five civil aircraft families in production--the 737, 747-400, 757, 767, and 777--already provided seating capacities from about 110 to 568 passengers with a full spectrum of flight ranges for domestic and intercontinental travel.[104] The MD-95, a 100-seat aircraft [105] that McDonnell Douglas was developing to meet demand in that market niche, held some interest for Boeing as a quick-to-market entry that extended its product range into the regional aircraft market. In January 1998, Boeing announced that the MD-95, renamed the Boeing 717-200, would be offered for sale as part of the Boeing product line.[106] Although this aircraft has limited commonality with other Boeing products, its advantages lie in its purpose-built design for the 100-seat market and status as the latest aircraft to enter this market. Boeing will discontinue production of McDonnell Douglas's other aircraft--the MD-80 and MD-90 twinjets and the MD-11 trijet--after orders are filled, as they reportedly lack sufficient customer support for continued production beyond current orders.[107] However, Boeing has committed its resources to support the McDonnell Douglas aircraft still in service.

Although the majority of Boeing's aircraft lines were developed and launched prior to 1992, since that time Boeing has developed four new variants of the 737, added a derivative of the 757, and delivered the first of its 777s. Boeing consulted extensively with its airline customers on the

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[102] Boeing agreed to maintain the civil aircraft business of McDonnell Douglas as a separate legal entity for 10 years and not to leverage its McDonnell Douglas customer base to gain greater dominance of the market; to license patents obtained as a result of defense contracts to other aircraft manufacturers, to submit any disputes over such licensing with the EU to arbitration, and to provide information on indirect support gained from government-funded research for a 10-year period; and not to enforce the exclusive supplier provisions of its agreements concluded with American, Continental, and Delta and not to enter into any such agreements for a 10-year period, "except where another aircraft manufacturer has offered such an agreement." For more information, see "Peace in Our Time," *The Economist*, pp. 59-61; "Boeing Deal Includes Arbitration Process on Patent Licensing Disputes," *Inside U.S. Trade*, Aug. 1, 1997, found at Internet address http://www.inside.trade.com/sec-cgi, retrieved Aug. 12, 1997; and "Boeing, EU Resolve Dispute Over Merger," *Aviation Week & Space Technology*, July 28, 1997, pp. 22-24.

[103] Boeing official, interview with USITC staff, Seattle, Feb. 10, 1998.

[104] See Appendix F for range and capacity of U.S., West European, and Russian large civil aircraft.

[105] For further information on the 100-seat market, see Chapter 6.

[106] "Boeing Introduces the 717-200 Airplane as New Regional Jet," PR Newswire, Jan. 8, 1998, found at Internet address http://www.newsedge, retrieved Jan. 9, 1998.

[107] Stanley Holmes, "Boeing Will Likely Phase Out MD-80, MD-90 Jet Production Lines," *The Seattle Times*, found at Internet address http://www.newsedge, retrieved Oct. 1, 1997, and "Boeing Announces Phase-Out of MD-11 Jetliner Program," PR Newswire, June 3, 1998, found at Internet address http://newsedge, retrieved June 4, 1998.

development of the 777 and carried this collaborative approach to the new 737 series, setting a precedent for future aircraft design.[108]

With the recent introduction of the new generation of 737s, Boeing now offers seven versions of this aircraft, a twin-engined narrow-body designed to meet a wide range of capacity (110 to 189 passengers) and route configurations. The 737 is widely flown by airlines employing a hub-and-spoke network within which large capacity aircraft would likely be underutilized and less cost effective.

The 747-400 wide-body is the world's largest commercial aircraft,[109] with a range of 7,250 nautical miles and seating for 420 passengers in 3 classes. This aircraft is the dominant operator in long-range, high-density markets, and is Boeing's most lucrative aircraft. The 757 and 767 aircraft were developed concurrently and delivered to launch customers within a 5-month period in 1982, with range and capacity configurations designed to fit between the 737 and 747. Boeing's newest aircraft family, the twin-engined 777, was designed to meet market demand for an aircraft that falls between the ranges and capacities of the 767 and 747.

Boeing is also evaluating the development of a large transport (typically seating more than 500 passengers) to satisfy anticipated long-term demand for a longer-range, higher-capacity aircraft. Because Boeing believes this market will not be large enough to warrant the costly development of an all new aircraft, Boeing is currently considering a larger derivative of the 747 with seating for an additional 70 to 100 passengers to compete in this market segment. A decision to offer this model could be reached by the end of 1998.[110]

Markets

With the addition of the McDonnell Douglas civil aircraft operations, Boeing currently accounts for 82 percent of the world's major passenger airline in-service LCA fleet of approximately 11,413 Western-built aircraft.[111] The Boeing aircraft line accounts for about 58 percent of the LCA in service, with the 737 series representing about 40 percent of the Boeing total (table 3-2). McDonnell Douglas aircraft represent an additional 24 percent of the LCA in service by commercial airlines; MD-80 models accounted for 41 percent of the McDonnell Douglas total (table 3-3). Boeing and McDonnell Douglas aircraft are primarily flown by North and South American airlines, which account for 53 percent of Boeing aircraft and 71 percent of McDonnell Douglas aircraft in service. Asian and Australian airlines operate the majority (51 percent) of wide-bodied 747s, primarily on intercontinental routes.

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[108] Stanley Holmes, "Boeing Asks Airlines for Advice on New 737s, and Old Customers Help Out," *The Seattle Times*, Nov. 17, 1997, found at Internet address http://www.newsedge, retrieved Nov. 18, 1997.

[109] In addition to the passenger version, Boeing offers the 747-400 freighter; a domestic version for short-range, high-density routes with seating for 568 passengers; and the combination version, which simultaneously carries passengers and cargo on the main deck.

[110] Jeff Cole and Stanley Holmes, "Boeing to Revive Plans for Larger Jumbo Jet," *The Seattle Times*, Sept. 9, 1998, found at Internet address http://www.newsedge, retrieved Sept. 10, 1998.

[111] Total includes LCA produced by Boeing, McDonnell Douglas, Airbus, Fokker, Lockheed Martin, and British Aerospace and in service as of August 1997. "World Airliner Census," *Flight International*, Oct. 15-21, 1997, pp. 46-52.

Table 3-2
Boeing: LCA in service, by region, as of August 1997

Aircraft types	Region				
	Africa	Asia, Australasia, and the Middle East	Europe	North and South America	Total
707	56	33	10	32	131
720	1	0	0	0	1
727-100	47	10	23	321	401
727-200	39	47	95	759	940
737-100	0	0	0	17	17
737-200	83	131	169	543	926
737-300	7	195	241	552	995
737-400	7	127	200	95	429
737-500	17	43	138	133	331
737-600[1]	0	0	0	0	0
737-700[2]	0	0	0	0	0
737-800[3]	0	0	0	0	0
747-100/SP	10	60	23	77	170
747-200	9	152	111	89	361
747-300	7	52	13	5	77
747-400	5	243	100	47	395
757	8	62	172	509	751
767-200	13	60	15	132	220
767-300	5	140	114	175	434
767-400[4]	0	0	0	0	0
777-200	3	46	14	26	89
777-300[5]	0	0	0	0	0
Total	317	1,401	1,438	3,512	6,668

[1] Delivered in September 1998.
[2] Delivered in November 1997.
[3] Delivered in April 1998.
[4] First delivery expected in May 2000.
[5] Delivered in June 1998.

Note.--Data encompass all Boeing commercial turbojet aircraft (passenger and cargo) in service worldwide with airline operators as of August 1997.

Source: “World Airliner Census,“ *Flight International*, Oct. 15-21, 1997, pp. 46-52.

Table 3-3
McDonnell Douglas: LCA in service, by region, as of August 1997

Aircraft types	Region				
	Africa	Asia, Australasia, and the Middle East	Europe	North and South America	Total
MD-11	0	46	47	72	165
MD-80	8	100	333	689	1,130
MD-90	0	24	10	19	53
DC-8	11	3	5	244	263
DC-9	9	9	90	676	784
DC-10	8	39	46	246	339
Total	36	221	531	1,946	2,734

Note.--Data encompass all McDonnell Douglas commercial turbojet aircraft (passenger and cargo) in service worldwide with airline operators as of August 1997.

Source: "World Airliner Census," *Flight International*, Oct. 15-21, 1997, p. 52.

Both the Boeing and McDonnell Douglas LCA operations benefited from the improved global market for LCA in the mid-1990s as airlines elected to replace older planes, add aircraft to service new routes, and increase frequencies.[112] Increased demand for Boeing's Next Generation 737 (table 3-4), orders of which grew by 86 percent during 1995-97, in large part spurred a 56-percent increase in announced deliveries during the same period (table 3-5). Although McDonnell Douglas's orders surged in 1995 to 130 aircraft, 38 percent of which were for the newly developed MD-95, aircraft deliveries during 1995-97 failed to attain earlier highs (tables 3-6 and 3-7). Orders for McDonnell Douglas aircraft failed to keep pace with those of other airframers after 1995, declining in successive years to 17 orders in 1997. Boeing garnered 54 percent of global LCA orders in 1997, down from 69 percent in 1996.

Table 3-4
Boeing: LCA net orders, by aircraft program, 1992-97

Aircraft program	1992	1993	1994	1995	1996	1997
737	111	101	66	172	449	320
747	24	2	16	39	75	37
757	35	33	12	13	59	45
767	22	53	15	22	44	98
777	42	20	0	92	85	51
Total	234	209	109	338	712	551

Source: Jet Information Services, Inc., *World Jet Inventory Year-End 1997*, Mar. 1998, p. 12.

[112] Boeing Commercial Airplane Group Marketing, *1988 Current Market Outlook*, June 1998, pp. 28- 35.

Table 3-5
Boeing: LCA deliveries, by aircraft program, 1992-97

Aircraft program	1992	1993	1994	1995	1996	1997
737	218	152	121	89	76	135
747	61	56	40	25	26	39
757	99	71	69	43	42	46
767	63	51	40	36	44	42
777	0	0	0	13	32	59
Total	441	330	270	206	220	321

Source: Jet Information Services, Inc., *World Jet Inventory Year-End 1997*, Mar. 1998, p. 14.

Table 3-6
McDonnell Douglas: LCA net orders, by aircraft program, 1992-97

Aircraft program	1992	1993	1994	1995	1996	1997
MD-11	7	6	4	9	10	11
MD-80	10	10	9	14	17	2
MD-90	26	0	0	57	18	4
MD-95	0	0	0	50	0	0
Total	43	16	13	130	45	17

Source: Jet Information Services, Inc., *World Jet Inventory 1997*, Mar. 1998, p. 12.

Table 3-7
McDonnell Douglas: LCA deliveries, by aircraft program, 1992-97

Aircraft program	1992	1993	1994	1995	1996	1997
MD-11	42	36	17	18	15	12
MD-80	85	43	23	18	12	16
MD-90	0	0	0	14	24	26
MD-95	0	0	0	0	0	0
Total	127	79	40	50	51	54

Source: Jet Information Services, Inc., *World Jet Inventory Year-End 1997*, Mar. 1998, p. 14.

Post-Merger Developments

Unfavorable industry and market reaction to Boeing's overall post-merger performance[113] has been reflected in its debt downgrading,[114] customer dissatisfaction, and somewhat diminished reputation in areas such as product quality and after-sales support.[115] Following the merger, Boeing was under pressure to quickly integrate its defense, space, and LCA acquisitions into its organizational network as well as to determine the future of McDonnell Douglas aircraft programs. At the same time, Boeing failed to anticipate fully the magnitude of looming LCA demand and the strain monthly production rate increases would impose on its manufacturing infrastructure. Problems resulting from this miscalculation were magnified by the broad cutbacks in employment and supplier bases that Boeing pursued with its transition to lean manufacturing[116] in the early 1990s, and the ongoing makeover of its production and procurement processes (discussed later in this chapter). Extensive production line inefficiencies were exposed, leading to a phased-in month-long shutdown of 747 production[117] and "rebalancing" of its 737 production line in October 1997.[118]

Boeing reached decisions on the fate of most of the McDonnell Douglas product range in fall 1997, and provided an overall integration scheme with the March 1998 release of a plan "to streamline facilities, focus manufacturing and assembly operations, and eliminate redundant laboratories."[119] Boeing continues to struggle with production and ramp-up difficulties, particularly on the 737 assembly line. Boeing also revised its future production schedule and

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[113] Following a fourth-quarter 1997 loss of $498 million, Boeing reported first-quarter 1998 net earnings of $50 million and second-quarter net earnings of $258 million for overall operations. Despite rising revenues, commercial aircraft operations generated declining losses of $251 million in first-quarter 1998 and $10 million in second-quarter 1998. "Boeing Reports 1998 1st Quarter Results, " Apr. 22, 1998, and "Boeing Reports 1998 2nd Quarter and First Half Results," July 23, 1998, Boeing press releases, found at Internet address http://www.boeing.com/news/releases/1998/news_release_980723a.html, retrieved July 27, 1998.

[114] Boeing's debt rating has been lowered to AA by Standard & Poor's, which usually leads to higher interest rates on borrowed money. Because Boeing operates with a relatively low debt load, however, this downgrading will likely have little or no effect on operations. Stephen H. Dunphy, "Standard & Poor's Lowers Boeing's Debt Rating," *The Seattle Times*, June 8, 1998, found at Internet address http://newsedge, retrieved June 10, 1998.

[115] See, for example, Holmes, "European Airline Executives Blast Boeing Production Problems;" "Boeing Earnings Take Another Hit," *The Seattle Times*, found at Internet address http://newsedge, retrieved Apr. 20, 1998; and Jeff Cole and Polly Lane, "Boeing Moves to Reduce Customer-Service Complaints," *The Seattle Times*, Nov. 11,1998, found at Internet address http://newsedge, retrieved Nov. 13, 1998.

[116] Lean manufacturing generally describes a streamlined production process that focuses on minimizing waste to reduce costs and maximize profits. Lean manufacturing includes a variety of production concepts, such as just-in-time inventory and production systems, emphasis on employee expertise in specific products, and modular manufacturing units, that can be implemented depending on company requirements.

[117] Boeing's 747 production difficulties arose in part as its subassembly manufacturers shifted work to the same group of consolidated upstream suppliers. Boeing official, interview with USITC staff, Seattle, Feb. 10, 1998.

[118] "Parts Shortages Slow Down Boeing Production," *Flight International*, Oct. 15-21, 1997, p. 11.

[119] "Boeing Reports 1998 1st Quarter Results," Boeing press release.

product mix to match its updated market outlook, reflecting softened Asian demand in the wake of the region's economic crisis.[120]

Future Directions

With the numerous demands on its resources resulting from the merger and the high level of current market demand, Boeing faces a number of competitive challenges. The merger appears to have had the greatest impact on global LCA market dynamics and Boeing's overall operations, which shifted from a primarily commercial aircraft operation to a more diversified aerospace producer. Conversely, the merger had fewer direct consequences for Boeing's LCA sector, the most obvious being the expansion of its product, engineering, personnel, and market bases. Boeing's broader business foundation may soften the financial and production effects of LCA cyclicality, but also requires extensive asset integration efforts. Moreover, Boeing's multiple new functions may create additional drains on financial and managerial assets, which could adversely affect the long-term competitiveness of Boeing's LCA sector. Finally, Boeing is responding to the industry-wide shift to commodity-type pricing in the global LCA market[121] by focusing on reducing costs, enhancing productivity, improving supply chain management, expanding market opportunities, and increasing foreign component sourcing to maintain or expand its 60-percent market share goal,[122] as discussed below.

Possible merger effects on Boeing

Subsequent to the Rockwell acquisition, the addition of McDonnell Douglas assets has posed serious management challenges to Boeing. The firm has had to address the harmonization of disparate corporate policies and operating systems, and integration of assets to optimize operational continuity. As with other U.S. defense companies that are assimilating major acquisitions, industry analysts have noted that Boeing's defense facilities integration seems rather problematic and slow paced despite the lack of program overlap relative to that of the LCA sector.[123] To improve its agility and focus, Boeing plans to divest itself of some noncore assets and "do fewer things in fewer places."[124] Moreover, integration requires not only the consolidation of physical assets, but also the blending of corporate cultures, work forces, and managerial lines

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[120] Frederic M. Biddle, "Boeing to Cut 747 Output 30% in 1999 and to Curtail Production of Its 777," *The Wall Street Journal*, June 10, 1998.

[121] Henkoff, "Boeing's Big Problem."

[122] Boeing official, interview with USITC staff, Seattle, Feb. 10, 1998.

[123] Anthony L. Velocci, Jr., "Boeing Integration Strategy Faces a Skeptical Audience," *Aviation Week & Space Technology*, May 11, 1998, p. 74.

[124] Mr. Harry Stonecipher, President and Chief Operating Officer of Boeing, as reported by Chris Genna, "Boeing Faces Plenty of Questions But Gives Few Answers at Farnborough," AeroWorldNet, Sept. 7, 1998, found at Internet address http://www.aeroworldnet.com/1in09078.htm, retrieved Sept. 11, 1998.

of command,[125] which has reportedly generated internal conflicts that have hampered smooth transition efforts.[126]

With respect to capital availability, many industry analysts expect Boeing to gain considerable cash flow from its strengthened post-merger position as a defense contractor. This flow may provide profit opportunities in LCA downturns and highly competitive pricing periods.[127] In addition, this cash flow could offset the cyclical nature of the LCA market by providing greater product and market diversification, which could bring greater stability to Boeing's financial performance.[128] With a more stable financial picture and greater cash flow, Boeing could potentially improve its overall financial standing and access to external capital resources to meet current obligations, and gain greater financial flexibility to fund future program developments and other productive interests.

Despite that potential, lagging integration efforts and lower profitability arising in part from LCA production problems and price pressures are currently having a negative impact on Boeing's financial position and shareholder value.[129] Lower profit levels as well as possible increased demands on its R&D and investment capital from its non-LCA operations could adversely impact the availability of financial resources for LCA manufacturing. Access to sufficient funding may not be critical in the short term in the absence of new program developments, but could become a significant factor in the medium to long term should the LCA market require totally new aircraft or technologies requiring high investment levels.

Boeing's takeover of McDonnell Douglas's commercial aircraft facilities may enhance its design and development skills with the infusion of McDonnell Douglas's engineering staff as well as improve its manufacturing capabilities by adding flexibility and capacity. McDonnell Douglas's highly skilled engineers are expected to make significant contributions to Boeing's design and manufacturing base,[130] such as improving Boeing's production costs and processes.[131] These employees, immersed in the McDonnell Douglas business culture, could introduce a different work

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[125] Boeing has also restructured its board of directors to more closely mirror the composition of the new company. With the inclusion of four former members of the McDonnell Douglas board, the new board has broader aerospace experience, more diverse perspectives on the industry, and greater expertise in government relations. As a result, the board may generate a wider spectrum of opinions and approaches to Boeing's decision-making processes and corporate philosophy. "Boeing to Face Scrutiny," *Puget Sound Business Journal*, Oct. 31, 1997, found at Internet address, http://newsedge, retrieved Nov. 6, 1997.

[126] Stanley Holmes, "Growing Pains, Part I: Boeing's Toughest Test Yet," *The Seattle Times*, Feb. 1, 1998, found at Internet address http://www.seattletimes.com/news/business/html98/boe_020198.html, retrieved Feb. 2, 1998.

[127] Stanley Holmes, "Boeing is Coming Up Short in Fat Times," *The Seattle Times*, Oct. 23, 1997, found at Internet address http://newsedge, retrieved Oct. 24, 1997.

[128] Revenues from this sector may range between $22 to $25 billion by 2002, with profit margins of 10 to 14 percent. Anthony L. Velocci, Jr., "Boeing Integration Strategy Faces a Skeptical Audience," *Aviation Week & Space Technology*, May 11, 1998, p. 75.

[129] Boeing recently announced its intention to increase shareholder value by targeting a 7-percent annual return on sales to be achieved through productivity improvements and consolidation gains. Jeff Cole, "Boeing Expects Upturn in Profits by Late 1999," *The Seattle Times*, July 23, 1998, found at Internet address http://newsedge, retrieved July 24, 1998.

[130] European airline official, interview with USITC staff, London, May 22, 1998.

[131] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 6, 1998.

experience[132] from which Boeing can draw new ideas, vitality, and approaches to aircraft design, development, and manufacturing. McDonnell Douglas's Long Beach, California, site has become the assembly, integration, and testing center for the 717-200 jetliner. Boeing is also reevaluating an earlier decision to add a Next Generation 737 final assembly line in Long Beach to supplement its Seattle area capacity, Boeing's prime LCA manufacturing site.[133] Long Beach had earlier been selected as the assembly site for business jets and other specialized versions of the 737, highlighting the production flexibility available to Boeing with the addition of this manufacturing location. In addition, Boeing has added parts-making capacity with the takeover of several plants that manufacture subassemblies and components for MD-series aircraft.[134]

Although McDonnell Douglas produced a relatively narrow LCA product range, Boeing's aircraft line will expand into the short-range, regional market at a relatively low cost with the addition of the 717-200. With smaller and larger derivatives of this aircraft to be developed if demand warrants,[135] Boeing is well placed to become a competitor in the niche market between the LCA and regional aircraft markets. The addition of the McDonnell Douglas in-service fleet also increased Boeing's installed base of in-service aircraft. With the growing importance of maintenance and support facilities on the earnings potential of aircraft and parts manufacturers, Boeing's larger installed base could create added revenue opportunities,[136] particularly as Boeing has shown interest in further developing its maintenance network.[137] A large installed base can also be a factor influencing the purchase decisions of major carriers, and can provide greater stability to subassembly and component manufacturers that supply the aftermarket.[138]

Responses to the changing LCA market

Acknowledging that technological evolutions for its current aircraft lines have been nearly exhausted,[139] intense price competition has driven Boeing to assemble jet aircraft at a faster pace, with a goal of reducing aircraft cost by 25 percent over 6 years and reducing cycle times[140] by 33 to 40 percent.[141] To achieve this objective, Boeing launched a complete overhaul of its dated, labor-intensive engineering, production, and procurement processes in 1994. Boeing introduced lean manufacturing to improve employee productivity, began reengineering its production lines,

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[132] European airline official, interview with USITC staff, London, May 22, 1998.

[133] Polly Lane, "Boeing Rethinks Plans for 737 Jet Assembly in Long Beach, Calif.," *The Seattle Times*, Oct. 20, 1998, found at Internet address http://newsedge, retrieved Oct. 21, 1998.

[134] See, for example, "Salt Lake Boeing Plant Prides Itself on High Productivity, Low Cost," *The Salt Lake Tribune*, July 20, 1998, found at Internet address http://newsedge, retrieved July 21, 1998.

[135] Boeing is interested in eventually launching a complete 717 family, including a 717-100 seating 80 to 85 passengers and a 717-300 that would carry 125 to 130 passengers. Mark Egan, "Boeing Unveils Newest Jet for Regional Carriers," Reuters News Service, The PointCast Network, June 10, 1998.

[136] European industry officials, interview with USITC staff, Paris, Apr. 3, 1998.

[137] Paul Proctor, "Boeing Buys Stake in Maintenance Center," *Aviation Week & Space Technology*, Aug. 18, 1997, p. 36.

[138] European industry officials, interview with USITC staff, Bonn, Apr. 1, 1998.

[139] Ron Woodard, President of Boeing Commercial Aircraft Group, as cited by Henkoff, "Boeing's Big Problem."

[140] The period between order and delivery of an aircraft.

[141] Holmes, "Growing Pains, Part 1: Boeing's Toughest Test Yet."

and shifted to just-in-time inventories.[142] Full implementation of this program has been delayed,[143] however, as Boeing resolves its more immediate production problems.[144] In other efforts to reduce costs, Boeing intends to reduce employment levels by 18,000 to 28,000 workers by the end of 1999,[145] and produce more standardized aircraft featuring common parts and limited options.[146] This step is intended to reduce production costs by reducing parts inventories, simplifying aircraft assembly, and cutting cycle times.

Boeing also is placing more emphasis on supply chain management[147] to reduce costs, increase response time, and improve product quality from a shrinking supplier base; encourage competition; and ensure the maintenance of multiple suppliers for major components.[148] To enable small parts manufacturers to better plan for the future and recoup their fixed investment costs, a difficulty associated with the cyclical nature of this industry, Boeing is pursuing long-term (5 to 10 years) contracts with their full supplier base.[149] With such an approach, Boeing hopes to maintain a healthy supplier base through lean demand periods.

To expand its market share, the company is looking to attract customers by incorporating greater commonality within its aircraft,[150] improving customer service, soliciting airline input in the aircraft development stage, adding a regional jet to its aircraft range, and exploring jumbo aircraft options. No totally new aircraft, however, are being considered for development at this time.[151]

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[142] This program is entitled Define and Control Airplane Configuration/Manufacturing Resource Management (DCAC-MRM). Holmes, "Growing Pains, Part 1: Boeing's Toughest Test Yet."

[143] The overhaul program is reportedly hindering the timely completion of aircraft assembly. The future of this program is under evaluation. Stanley Holmes, "Boeing Puts Process of Revamping Production on Hold," *The Seattle Times*, Oct. 22, 1998, found at Internet address http://newsedge, retrieved Oct. 27, 1998.

[144] In response to unsatisfactory production and financial showings in the LCA sector, Boeing installed new management in its Commercial Aircraft Group, including a new group president, in September 1998. Jeff Cole, "Boeing Removes President of Commercial Airplane Group," *The Seattle Times*, Sept 1, 1998, found at Internet address http://newsedge, retrieved Sept. 2, 1998.

[145] "Boeing Announces Additional Consolidation and Realignments," Boeing press release, Aug. 13, 1998, found at Internet address http://www.boeing.com/news/releases/1998/news_release_980813a.html, retrieved Aug. 14, 1998.

[146] Holmes, "Growing Pains, Part 1: Boeing's Toughest Test Yet."

[147] See the section on Effects of U.S. and EU LCA Industry Structural Changes in this chapter for more information.

[148] Boeing official, interview with USITC staff, Seattle, Feb. 10, 1998.

[149] Ibid. For example, Boeing recently negotiated 10-year contracts with major aluminum producers to ensure a continuous supply of metal. Frank Haflich, "Boeing Pacts: Firm on Prices, Less on Path," *American Metal Market*, Sept. 2, 1998, p. 1.

[150] Boeing reported in 1996 that its ". . . fundamental strategy is to maintain a broad product line responsive to changing market conditions by maximizing commonality among the Boeing family of commercial aircraft." U.S. SEC, Boeing Form 10-K Annual Report for Fiscal Year 1996.

[151] Henkoff, "Boeing's Big Problem."

Lastly, Boeing will likely increase foreign parts production in recognition of the global nature[152] of the LCA industry,[153] targeting countries with restricted market access and predicted to become major aircraft purchasers.[154] Foreign parts procurement has become an important market access strategy driven by the industrial development ambitions of many overseas markets.[155] Airframers often source less complex and technology-intensive components from newer foreign suppliers through production offsets,[156] which generally serve as a gateway to enhanced sales opportunities. Sourcing from lower-cost manufacturing sites may also contribute to reduced aircraft production costs.

The West European Large Civil Aircraft Industry

Airbus Industrie, G.I.E.

Background

The Airbus consortium[157] developed out of West European government beliefs that the survival of their leading aerospace companies was threatened by the increasing popularity of U.S. aircraft designs, and that a cooperative approach to LCA design would foster a stronger competitive position. Airbus principally serves as the management, marketing, sales, and service arm for the consortium's aircraft lines. The consortium partners share in the design and manufacture of Airbus aircraft, with each member responsible for the production of specific aircraft assemblies.[158] Design responsibilities are located in Toulouse, France, as well as final assembly of certain Airbus

[152] See, for example, "Business for Boeing Means Business for Europe," speech by Mr. Ron Woodard, President, Boeing Commercial Airplane Group, at European Aviation Club, Brussels, Boeing press release, Feb. 10, 1998, found at Internet address http://www.boeing.com/news/speeches/current/europe, retrieved June 30, 1998.

[153] Boeing officials have noted that although Boeing assembles nearly 85 percent of its aircraft in the United States, about 70 percent are sold to non-U.S. customers. "Company Must Increase Its Overseas Production, Commercial Airplane Group President Insists," *Morning News Tribune*, Nov. 21, 1997, found at Internet address http://newsedge, retrieved Nov. 25, 1997; and "Boeing Takes the Gloves Off," *Aviation Week & Space Technology*, Dec. 1, 1997, p. 13.

[154] Boeing official, interview with USITC staff, Seattle, Feb. 10, 1998.

[155] Ibid.

[156] See Appendix G for a discussion of offsets.

[157] Airbus began operations in 1970 and is currently owned by the following four partners: Aérospatiale (France) and Daimler-Benz (Germany)--through its subsidiary Deutsche Aerospace Airbus (DASA)--with 37.9 percent each; British Aerospace (BAe) with 20 percent; and Construcciones Aeronáuticas S.A. (CASA) of Spain with 4.2 percent. Several other companies, including Alenia (Italy) and Belairbus (Belgium), participate in certain programs as risk-sharing associates.

[158] Aérospatiale manufactures the cockpit, forward fuselage and some center fuselage/wingbox sections, engine pylons, and lift dumpers; British Aerospace produces the wings; Daimler-Benz builds fuselage sections, the vertical tail, tail cones, rudders flaps, spoilers, flap fairings, and assembles wing sections; and CASA manufactures horizontal stabilizers, elevators, nose landing gear doors, and forward cabin entry doors. Airbus, found at Internet address http://www.airbus.com/overview.html, retrieved Jan. 8, 1998.

aircraft at Aérospatiale's facility; the remaining Airbus planes are assembled at Daimler-Benz's Hamburg operations.[159]

Airbus is widely recognized for its technological innovations and implementation of cross-program commonality. Airbus has also gained production efficiencies with partners' internal improvements[160] and the implementation of modular assembly.[161] However, Airbus still lacks certain business elements, such as a complete product lineup and an instilled service culture.[162] Moreover, certain inherent features of its current corporate structure, such as the lack of centralized decision making, have hampered Airbus's ability to operate as efficiently and responsively as possible.

Overview of G.I.E. Corporate Structure

Airbus is currently organized as a *groupement d'intérêt économique* (G.I.E.) under French law.[163] A G.I.E. is a type of joint venture that has a legal identity separate from its members and which has no fixed capital contribution requirements. Each partner operates under the law of the country in which it is incorporated, thus eliminating the need to manage conflicting national tax and legal structures. Like a partnership in the United States, a G.I.E. is not required to report financial results or pay taxes on its profits unless it so elects;[164] however, G.I.E. partners must comply with their respective national legal and tax codes with respect to tax payments on overall corporate profits. Members of a G.I.E. are jointly and separately liable, without limitation and in proportion to their respective membership rights, for the G.I.E. debts and obligations.[165] Since Airbus member companies need not share information about their costs, neither the member companies nor Airbus (with the exception of the financial director) know the actual cost of manufacturing Airbus planes. This lack of transparency decreases the amount of oversight and control that partners can exert over Airbus.

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[159] Aérospatiale performs final assembly of the A300, A310, A320, A330, and A340; Daimler-Benz performs final assembly of the A321 and A319. Airbus, found at Internet address http://www.airbus.com/
overview.html, retrieved Jan. 8, 1998.

[160] For example, DASA completed an extensive overhaul of its operations in 1997 to improve the competitiveness of its Airbus assembly lines. Oliver Sutton, "Ramping Up Airbus Production," *Interavia*, May 1998, p. 28.

[161] Airbus has already shifted A330/340 production in Toulouse from linear assembly to a modular flow system, eliminating production blockages and decreasing aircraft movement, which has led to a leaner manufacturing system with little down time. Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[162] Airbus Industrie presentation to USITC staff, Toulouse, France, Apr. 7, 1998.

[163] This type of organization was created in France by Ordinance No. 67-821 of Sept. 23, 1967, and Decree No. 68-109 of Feb. 2, 1968.

[164] Gellman Research Associates, Inc., for the U.S. Department of Commerce, *An Economic and Financial Review of Airbus Industrie* (Jenkintown, PA: Sept. 4, 1990), p. 1-2, and George Eberstadt, "Government Support of the Large Commercial Aircraft Industries of Japan, Europe, and the United States," contractor document for Office of Technology Assessment, *Competing Economies: America, Europe, and the Pacific Rim* (Washington, DC: Congress of the United States, 1991), p. 236.

[165] "Responses of Airbus Industrie, G.I.E., to Questions Regarding the ITC's Study on Global Competitiveness of the U.S. Aircraft Industry," tab J.1; and Gellman, *An Economic and Financial Review of Airbus Industrie*, p. 1-2.

A French G.I.E. can amass resources, including financial resources, that individual U.S. corporations may not be able to match. Moreover, the G.I.E. method of pooling resources does not impinge upon the autonomy of its members.[166] In the case of Airbus, the G.I.E. provides benefits such as cooperation on a full partnership basis;[167] merging the technical strengths of the partners; freeing access to large sums of capital; pooling a large resource base, in terms of both funds and technology; spreading risk and costs among a larger base; and facilitating membership of new parties. The G.I.E. structure also allows member firms to work on a group project as a consortium, while also offering partners the option to pursue other noncompetitive projects independently.[168]

Although G.I.E. status confers several benefits, a major drawback appears to be the number of partners with voices in corporate decision-making processes. Because each Airbus shareholder is also a source of its manufacturing inputs, partners may make decisions that may not reflect the best interests of Airbus as a whole. Airbus partners have demonstrated a tendency to optimize their positions as shareholders/suppliers rather than working to gain the best results for Airbus.[169] As a result, decision making can be more complex and sometimes slower than in a fully integrated corporation.[170] Problems can also arise when customers seek product support because Airbus must refer the customer to the responsible consortium member, which can lead to delays and a lack of cohesiveness in operations.[171] Industry sources also point out that because of the partners' dual roles as owners/suppliers, Airbus may not obtain the best-valued aircraft components in part because of the absence of vigorous outside competition and duplication of business functions,[172] as well as its inability to consolidate component purchases among its suppliers. The partners' dual roles may also limit offshore component sourcing[173] at a time of increasing industry globalization and the expectations of certain purchasing countries to share in some aspect of aircraft production in return for market access.

Products

Airbus undertook an ambitious expansion program in the late 1980s and early 1990s. During that period, the company doubled the number of aircraft offered with the first deliveries of four new aircraft lines during 1992-96, including the A319, A321-100, A330-300, and two derivatives of the A340. These aircraft filled gaps in Airbus's product line, which now provides typical seating

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[166] Transcript of hearing for USITC investigation No. 332-332, Apr. 15, 1993, pp. 182-183, 191, 222; and Mary Anne Rose, *Airbus Industrie: High Technology Industrial Cooperation in the EC-Structure, Issues, and Implications with a View Towards Eurofar,* paper for conference on The European Community in the 1990s, Emerging Concepts and Priorities, George Mason University, May 24-25, 1989 (San Jose, CA: San Jose State University Foundation for NASA Ames Research Center, May 1989), p. 11.

[167] "Responses of Airbus Industrie," tab J.2.

[168] Ibid.

[169] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[170] "Responses of Airbus Industrie," tab J.2.

[171] Ibid.

[172] "The Sole Competitor," *Fortune*, Jan. 12, 1998, found at Internet address http://www.pathfinder.com/fortune/1998/980112/boe2.html, retrieved Jan. 12, 1998.

[173] Aerospace Industries Association, Inc. officials, interview with USITC staff, Washington, DC, Dec. 3, 1997.

capacities from 124 to 380 passengers,[174] and provided competition for many of Boeing and McDonnell Douglas's existing LCA.

Despite this product line expansion, Airbus lacks an entry in the large (more than 400 seats), long-range market [175] currently dominated by the Boeing 747. To expand its product range, Airbus is developing the A3XX aircraft. The first model is to be optimized at 550 seats with an expected launch by the end of 1999 and delivery by late 2004.[176] Because of the extremely high costs (estimates range between $10 to $20 billion[177]) associated with this project, Airbus has taken on other partners in this venture.[178] At the other end of the spectrum, Airbus recently announced its decision to develop the A318--a shrink version of the A319--for the 100-seat market, with a projected service date of 2002.[179] This aircraft would be a relatively low-cost, quick-to-market competitor for the Boeing 717-200 now that its 100-seater project[180] through Airbus Industrie Asia has been canceled.[181]

The appeal of Airbus's narrow-bodied A320 family is derived in part from the incorporation of innovative technologies and simplified cockpit designs (e.g., the sidestick controller and fly-by-wire system have become standards on later Airbus aircraft), and a competitive operating cost relative to its main competitor, the first generation Boeing 737s. Cockpit commonality extends throughout the A320 family,[182] permitting a common pilot type-rating for all three aircraft.[183] The A330/340 wide-bodies serve longer routes and carry more passengers than their A320 counterparts, but they share the same cockpit (with minor variations), which facilitates crew cross-qualification between the narrow- and wide-bodied airliners.[184] Airbus is also exploring, and in some cases launching, derivatives of the A330 and A340[185] to gain entry into the growing 300- to 400-seat, long-range aircraft market currently dominated by Boeing.

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[174] The A330-300 can be configured for a high-density arrangement of 440 passengers. Paul Jackson, ed., *Jane's All the World's Aircraft 1997-98* (Surrey, UK: Jane's Information Group Limited, 1997), p. 184.

[175] For further information on the 500-seat market, see Chapter 6.

[176] "Airbus Readies Challenge to 747's Long Dominance," *Puget Sound Business Journal*, June 5, 1998, found at Internet address http://newsedge, retrieved June 10, 1998.

[177] Cole and Holmes, "Boeing to Revive Plans for Larger Jumbo Jet."

[178] Alenia, Belairbus, Fokker (the Netherlands), Saab (Sweden), and Finavitec (Finland) all own shares in the A3XX program.

[179] Pierre Sparaco, "Airbus to Launch Boeing 717 Rival," *Aviation Week & Space Technology*, Sept. 14, 1998, p. 26.

[180] For further information on the status of this 100-seat aircraft program, see Chapter 5.

[181] See section on Airbus Industrie Asia in this chapter for more information.

[182] Includes the A319 (124 seats), A320 (150 seats), and A321 (185 seats). Airbus Current Family, found at Internet address http://www.airbus.com, retrieved July 16, 1998.

[183] Crew cross-qualification lowers the cost of training by highlighting the differences in the aircraft rather than learning an entirely new aircraft, thereby decreasing an airline's expenditure on pilots/cabin staff.

[184] "25 Flying Years," *Flight International* supplement, Oct. 29, 1997-Nov. 4, 1997.

[185] "Airbus Gives Go-Ahead for A340-500/600," PR Newswire, Dec. 8, 1997, found at Internet address http://www.newsedge, retrieved Dec. 9, 1997; and Michael Skapinker, "Lufthansa to Buy Ten A340-600s," *Financial Times*, Dec. 5, 1997, p. 3. The A340-500 will carry 313 passengers in a three-class interior layout, with maximum seating capacity of 440 passengers. The A340-600 will accommodate 380 passengers in a typical three-class cabin. Deliveries of the A340-600 are scheduled to begin in early 2002, with those of the A340-500 to follow in several months. Airbus, found at Internet address http://www.airbus.com, retrieved Sept. 4, 1998.

Markets

The resurgence of the global aircraft market since 1995 had an equally positive effect on deliveries and orders for Airbus as for the other LCA manufacturers. With a fourfold increase in its aircraft orders since 1995, Airbus dramatically increased its production, as exemplified by the 48-percent increase in deliveries to 182 aircraft in 1997 (tables 3-8 and 3-9). Airbus gained 44 percent of global LCA orders in 1997, up from 29 percent in 1996.

Of the approximately 11,413 Western-produced LCA in service globally, Airbus presently accounts for 13 percent. Airlines in Europe and Asia/Australia account for 37 percent and 35 percent, respectively, of these Airbus aircraft (table 3-10). The bulk of Airbus aircraft in service with airline operators are A300 wide-bodies, which are mainly used in the Asian/Australian region on high-density routes, and A320 single-aisle aircraft, which dominate the Airbus presence in Europe and North and South America where the demand for mid-range, medium-capacity aircraft has been more prevalent.

Table 3-8
Airbus Industrie: LCA net orders, by aircraft program, 1992-97

Aircraft program	1992	1993	1994	1995	1996	1997
A300	16	3	0	2	15	6
A310	13	3	0	4	0	1
A319	6	0	41	30	51	240
A320	58	13	27	39	128	73
A321	9	0	18	12	45	50
A330	1	2	2	9	42	64
A340	20	14	27	7	33	25
Total	123	35	115	103	314	459

Source: Jet Information Services, Inc., *World Jet Inventory Year-End 1997*, Mar. 1998, p. 12.

Table 3-9
Airbus Industrie: LCA deliveries, by aircraft program, 1992-97

Aircraft program	1992	1993	1994	1995	1996	1997
A300	22	22	23	17	14	6
A310	24	22	2	2	2	2
A319	0	0	0	0	18	47
A320	111	72	48	33	38	58
A321	0	0	16	22	16	22
A330	0	1	9	30	10	14
A340	0	22	25	19	28	33
Total	157	139	123	123	126	182

Source: Jet Information Services, Inc., *World Jet Inventory Year-End 1997*, Mar. 1998, p. 14.

Table 3-10
Airbus Industrie: LCA in service, by region, as of August 1997

	Region				
Aircraft types	Africa	Asia, Australasia, and the Middle East	Europe	North and South America	Total
A300	28	214	91	76	409
A310	13	72	86	55	226
A320	24	136	230	192	582
A321	3	10	62	0	75
A330	0	46	13	1	60
A340	7	38	55	8	108
Total	75	516	537	332	1,460

Note.--Data encompass all Airbus commercial turbojet (passenger and cargo) aircraft in service worldwide with airline operators as of August 1997.

Source: “World Airliner Census,” *Flight International*, Oct. 15-21, 1997, pp. 42-44.

Future Directions

Airbus's most significant goal is the formation of a single corporate entity (SCE), requiring the total reorganization of its corporate structure to enhance competitiveness in the current price-conscious aircraft market. Airbus expect to achieve greater operating efficiencies and expanded access to international funding for future program investments with the SCE. Airbus also shares common industry concerns about reducing costs, improving processes and organization, and increasing globalization. In addition, Airbus is placing a priority on developing more derivatives of its current aircraft families, exploring opportunities in the regional jet and jumbo aircraft markets, and responding to customer needs, such as improved operational capability, support, and passenger comfort, to achieve its goal of a 50-percent share of the global aircraft market.[186]

Proposed changes to Airbus operating structure and possible effects

The restructuring of Airbus may improve its ability to meet future global LCA market demands, undertake the successful development of new aircraft, and compete with Boeing in existing and future market sectors. The single corporate entity is expected to enhance cycle times, productivity, profitability, and customer support by consolidating authority and responsibility for Airbus under a single corporate management.[187] In the long term, Airbus will likely gain operating cost reductions through streamlining and efficiency improvements, more flexibility to outsource aircraft components, and access to greater financial resources in international markets. Airbus will also be able to focus more sharply on profits, which may have long-term implications for strategic planning. However, self-imposed restrictions on operating flexibility and unresolved internal differences may undermine its maximum performance levels and hinder its complete engagement with the global LCA market. The persistent challenge of accommodating the partners' divergent cultural and political concerns during the transition process has contributed to a delay in this shift to an SCE,[188] from January 1, 1999, to sometime in 1999.[189]

The G.I.E. structure has proved to be a successful means to launch a globally competitive European LCA company. However, changes in the global market have forced the partners to pursue a more responsive, efficient SCE structure to cope with the demand for more industrial cooperation with LCA producers in foreign markets, declining levels of government funding[190] and increased General Agreement on Trade and Tariffs (GATT) supervision, shareholders' expectations, and the need to compete with Boeing more effectively.[191]

One of the most significant operational and competitive improvements for Airbus will be the shift to centralized management and decision making that will concentrate on Airbus, rather than

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[186] "Boeing and Airbus Report 1997 Orders/Deliveries," Jan. 12, 1998, AeroWorldNet, found at Internet address http://www.aeroworldnet.com/1tw01128.htm, retrieved Jan. 13, 1998.

[187] British Aerospace, 1996 Financial Statement; and Airbus Industrie North America officials, interview with USITC staff, Herndon, VA, Nov. 20, 1997.

[188] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998; and European industry official, interview with USITC staff, London, Mar. 29, 1998.

[189] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[190] To comply with Maastricht Treaty monetary union criteria, European governments are obliged to maintain budget deficits of 3 percent or less of gross domestic product, thus constraining government spending.

[191] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

partner, goals.[192] The SCE will have sole accountability for the actions and responsibilities of the company, will gain control of its industrial assets,[193] and will present a single point of contact for its customers and suppliers. The partners are making progress in developing this new management structure, and have appointed a chief executive officer.[194] Corporate headquarters will remain in Toulouse, but Airbus has yet to announce where the firm will be registered for tax purposes.[195]

Airbus's new cohesive organizational structure is expected to be more attractive to international financial markets,[196] creating opportunities to amass a larger, more diversified financial base to pursue new program developments and other productive ventures in addition to the direct government support currently provided through the partners.[197] Airbus's financial performance and reporting are expected to be more transparent, and therefore more responsive to market conditions as the company moves to internationally accepted business accounting principles. By knowing its real costs, Airbus may better target cost-reduction measures at its production facilities, allocate its financial and industrial resources among future business pursuits, and focus on profitability[198] to attract private capital in competitive financial markets.

Airbus's ability to capitalize on the advantages offered by full integration into international financial markets, however, may be hindered by limitations it has placed on its flexibility to raise capital. Equity in Airbus is not expected to be offered to the public in the near term.[199] Airbus will rely only on its partners to provide financial backing in the initial stages of the SCE until the

[192] Ibid.

[193] The LCA design, engineering, procurement, and manufacturing assets and resources of the partners will be transferred to the restructured company. Although Aérospatiale was reluctant to relinquish control of its manufacturing facilities to a consolidated Airbus, Aérospatiale announced its intent to spin off its Airbus business in late 1998 and transfer this subsidiary to Airbus. David Owen, "Aérospatiale Spins Off Business," *Financial Times*, Jan. 14, 1998; and Paul J. Devery, "Airbus Conversion Gets a Lift," *Wall Street Journal*, Jan. 14, 1998. BAe and Daimler-Benz had previously agreed to transfer their assets to a restructured Airbus. This difference arose in part because the British and German partners maintain separate Airbus operations, whereas Airbus business is mingled with other Aérospatiale operations. Airbus Industrie North America officials, interview with USITC staff, Herndon, VA, Nov. 20, 1997.

[194] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[195] Michael Skapinker, "Consolidation is the Name of the Game," *Financial Times*, Sept. 3, 1998. The Netherlands has been cited as a possible registration site because of its favorable tax rates. Pierre Sparaco, "European Industry Readies for Monetary Unification," *Aviation Week & Space Technology*, Aug. 10, 1998, p. 60.

[196] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[197] The level of direct financial support provided by Airbus partner governments is not readily available.

[198] According to company officials, the restructuring will increase Airbus's profitability and generate a greater return on investment. "Airbus Stays on Track for 232 Jet Deliveries in 1998," Reuters, The PointCast Network, Nov. 10, 1998. Although Airbus does not issue public financial statements, Daimler-Benz, parent of Airbus partner DASA, has included Airbus profit-and-loss data in its annual reports since 1996. Airbus recorded a $147-million profit in 1997, down 61 percent from the 1996 level of $410 million. "Airbus Profit Drops 17% in '96," May 7, 1997; and "Airbus Profit Plunges 61% in '97," Apr. 9, 1998, *The Seattle Times*, both found at Internet address http://archives.seattletimes.com, retrieved July 22, 1998.

[199] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

company is able to gain international financing.[200] During this period, the partners will raise capital independently to fund any necessary financial requirements, albeit without direct control over the allocation or use of these funds. Although Airbus will be able to take on risk-sharing partners for new projects such as the A3XX,[201] the existing partners will initially only be able to sell shares to outside interests with unanimous consent. This constraint not only allays concerns that major shareholders could leave Airbus before reaching its full maturity,[202] but also retains Airbus for the original four partners that have made significant investments in the company. By delaying a public stock offering, Airbus restricts its shareholder base, thus directly avoiding external pressures from outside shareholders and international financial markets to achieve certain financial performance criteria at the expense of market share or other corporate goals. The partners are still negotiating the final terms for a common financial policy.[203]

In the long term, centralized decision making under an SCE should permit optimized manufacturing, higher productivity, greater purchasing efficiencies, and improved pricing flexibility. Although no significant short-term changes are expected in current operations, certain production flow shifts, such as reducing inventories and lead times, will be inevitable to improve efficiencies.[204] Some supplier contracts may be renegotiated to consolidate purchasing processes and reduce the duplicative efforts of suppliers dealing with four partners, which may lead to a decrease in the price of goods because of harmonized procurement and volume purchases.[205]

In principle, Airbus will be free to outsource and open contracts to competitive bidding. However, Airbus asserts that current work-share arrangements have led to economies of scale and a high degree of technological expertise that generally place Airbus partners at an advantage over any other suppliers.[206] The internal pressure to continue current work-share arrangements will likely lead to a moratorium on outsourcing,[207] which may affect Airbus's ability to fully realize lower component costs and improved market access opportunities that would be possible with the SCE. Although Airbus has indicated interest in gaining market access through production offsets, the partners have often been reluctant to follow through with this strategy.[208] Such shifts in sourcing patterns may occur in future programs that will more easily permit purchasing from nonpartners because of early integration into program design and development.

Of the issues still under discussion,[209] the most notable is asset valuation and shareholder ownership of the new company. To establish new ownership allocations in the SCE, the value of individual partner assets contributed to the restructured Airbus must be determined, as well as the

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[200] Daimler-Benz, parent of DASA, and British Aerospace are listed on public stock exchanges, thus indirectly providing Airbus access to international financial markets.

[201] European industry official, interview with USITC staff, London, Mar. 29, 1998.

[202] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[203] Pierre Sparaco, "Airbus Boosts Production, Eyes Early A3XX Launch," *Aviation Week & Space Technology*, May 25, 1998, pp. 31-33.

[204] Airbus Industrie officials, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[205] Ibid.

[206] Ibid.

[207] Ibid.

[208] Ibid.

[209] Because of the different perspectives on legal and tax codes and labor issues that the partners bring to the negotiating table, the selection of a common legal structure and human resources policy is still under review. Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

overall value of the company. The partners are reportedly at the beginning of this sensitive process.[210] Resolution of this issue has also been complicated by the different capital structures of the partners.[211] For example, the continued majority ownership of Aérospatiale by the French Government and its implications for the future operations of a new Airbus have been cited as a hindrance to the complete transition of Airbus to an SCE by its British and German partners,[212] who assert that Airbus must be privately owned.[213] In an effort to allay such concerns and facilitate restructuring, the French Government has reportedly agreed to Aérospatiale's privatization principally through its merger with Matra Hautes Technologies, a French defense firm owned by French investment company Lagardère S.C.A.[214] This move may enable Aérospatiale to gain a stock market valuation, considered essential to the SCE transition.[215]

Other European Industry Structural Changes

European Consortia

The aircraft manufacturing consortia that emerged in Europe during 1992-97 supplied the framework for individual companies to pool their technical, industrial, and financial resources to gain economies of scale while sharing the monetary risks inherent in the pursuit of new aircraft projects. These consortia provided a means for individual companies with limited assets and risk-taking capability to develop new aircraft. Cultural and national differences, contrasting philosophies and goals, and varying financial positions of the individual partners, however, are inherent weaknesses that can undermine the long-term success of such ventures. Two such consortia--Aero International (Regional) (AI(R)) and Airbus Industrie Asia (AIA)--were established with European partners to develop, produce, and market smaller regional transports. Although the two consortia explored the launch of new aircraft, both projects encountered serious development problems that led to their cancellation.

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[210] Stanley Holmes and Jeff Cole, "Price War with Boeing Pares Profits at Airbus," *The Seattle Times*, Sept. 20, 1998, found at Internet address http://newsedge, retrieved Sept. 22, 1998.

[211] Aérospatiale and CASA are currently majority owned by their respective governments, DASA is owned by Daimler-Benz, and British Aerospace is a publicly held company.

[212] Skapinker, "Consolidation is the Name of the Game."

[213] Pierre Sparaco, "Airbus 'Single Entity' Faces Further Delay," *Aviation Week & Space Technology*, Sept. 21, 1998, p. 45.

[214] Under this scenario, the French Government would hold between 45 and 49.9 percent of Aérospatiale; Lagardère S.C.A., 30 to 33 percent; and employees, 3 to 4 percent. The remaining shares would be listed on the public stock market or offered to other partners. "Aerospatiale-Matra Alliance Put in Context," *Paris Liberation*, Foreign Broadcast Information Service, July 23, 1998, found at Internet address http://fbis.fedworld.gov (FBIS translated text), retrieved July 27, 1998; and "Major Strategic Partnership," Lagardère press release, July 23, 1998, found at Internet address http://www.lagardere.fr/
us/actualite/index.html, retrieved July 28, 1998.

[215] "French Aerospace Industry Officially Favored," *Paris Air & Cosmos/Aviation International*, Foreign Broadcast Information Service, July 15, 1998, found at Internet address http://fbis.fedworld.gov (FBIS translated text), retrieved July 27, 1998.

Aero International (Regional)

Prior to its breakup in April 1998, AI(R) was the world's largest supplier of aircraft to the regional airline industry.[216] Three European aerospace partners--Aérospatiale, Alenia, and BAe[217]--maintained individual responsibility for the industrial and financial support of their respective aircraft programs.[218] They included the Aérospatiale-Alenia ATR program[219] and British Aerospace's AVRO and Jetstream[220] aircraft, which formed a family of complementary turboprop and turbojet transports ranging in size from 30 to 128 passengers.

Their efforts to develop a new regional AI(R)JET series[221] to meet growing demand in the 40- to 90-seat category met with eventual failure when BAe decided not to make any major investment in the AI(R)JET project, citing previous losses on its regional aircraft programs, uncertain support from the other AI(R) partners, and its focus on funding the development of the Airbus A340-500/600 project.[222] Subsequently, in December 1997 AI(R) decided not to continue with the 70-seat regional aircraft program, citing the decision by the AI(R) partners to focus their financial and engineering resources on Airbus's new aircraft projects.[223]

Following its decision to cancel the 70-seater program, in April 1998 the three AI(R) partners announced the dissolution of the consortium. Aérospatiale and Alenia will continue to market and

[216] According to the Regional Airline Association (RAA), regional airlines are short-haul scheduled carriers providing service between small- and medium-sized communities and the nation's hub airports. This service is primarily provided with turboprop aircraft with 19 to 70 seats, although some airlines operate small turbofan aircraft with 50 to 100 seats. E-mail correspondence from RAA official, Jan. 9, 1998.

[217] Each partner held a one-third share of the company, which began operations on January 1, 1996, with headquarters in Toulouse, France.

[218] Paul Jackson, ed., *Jane's All the World's Aircraft 1996-97* (Surrey, UK: Jane's Information Group Limited, 1996), p. 175.

[219] Like Airbus, the ATR joint venture was incorporated under French law as a *groupement d'intérêt économique*, with its formal establishment in February 1982.

[220] In May 1997, however, BAe announced that the company would end production of its Jetstream aircraft program, in part because of the large losses incurred on this product, slack demand for new small turboprop aircraft as an increasing number of used turboprops became available, and the economics of flight frequencies and cycles that dictate the use of turbojets on certain routes. Jetstreams in service will continue to be supported and maintained by BAe. British Aerospace, 1996 Financial Statement.

[221] The AI(R)JET series initially included a 70-seat version, to be followed by a 58-seat model and a stretched version, at an estimated cost of $1 billion. AI(R) had hoped to vertically integrate the company around the 70-seat project. Pierre Sparaco, "European Airframers Merge to Build Muscle," *Aviation Week & Space Technology*, found at Internet address http://www.newsnet.com/libiss/ae30.htm#atr, and Aero International (Regional), found at http://www.airegional.com/about.html, both retrieved Sept. 11, 1997; and AI(R) official, interview with USITC staff, Toulouse, France, Apr. 8, 1998.

[222] Kevin O'Toole, "BAe Rules Out Becoming Major Air Jet Investor," *Flight International*, Sept. 17-23, 1997, p. 6.

[223] Charles Goldsmith, "European Plane Consortium Opts Not to Build 70-Seat Regional Jet," *The Wall Street Journal*, Dec. 11, 1997.

produce ATR turboprops, and are reportedly reevaluating the AI(R)JET program.[224] BAe Regional Aircraft will focus on its AVRO regional jet line, including derivatives of its RJ series.[225]

Airbus Industrie Asia

AIA, a subsidiary of Airbus and Alenia/Finmeccanica, was formed in early 1997 as a joint-venture partner with Aviation Industries of China (AVIC) and Singapore Technologies Pte Ltd. (STPL). The venture focused on a $2-billion project[226] to develop a 100-seat regional jet[227] that would fulfill China's ambition to build a commercial aircraft and extend Airbus's product range into the 100-seat market. Following numerous development problems, however, the project was terminated in July 1998.[228]

As proposed, the regional aircraft program--named the AE-31X[229]--would have had many features in common with the A320, including the same type-rating.[230] Much of the manufacturing of the AE-31X and its final assembly was to occur in China, with the European partners providing expertise and technology in such areas as engineering, production, and customer support.[231] Several obstacles thwarted the project's completion, however, including the level of technology that the European partners were willing to transfer, its valuation and payment terms, and program cost.[232]

British Aerospace

BAe is one of the world's leading aerospace and defense companies, with annual sales exceeding £7 billion (about $10.5 billion). BAe is also a partner in numerous civil and military programs worldwide, including Airbus and the former AI(R) on the commercial side. With its membership in these ventures and the sale of its Corporate Jet division to Raytheon (United States)[233] in June

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[224] Pierre Sparaco, "Europeans Begin to Dismantle AIR," *Aviation Week & Space Technology*, May 4, 1998, p. 30.

[225] Pierre Sparaco, "AIR's Failure May Boost Avro," *Aviation Week & Space Technology*, Mar. 2, 1998, p. 45.

[226] "China's Plan for a New 100-Seat Jet Carrier: A High Risk for Europe?," *Clear Thinking, Construction Newsletter*, Aug. 1996, found at Internet address http://www.redfish.com/Clear-Thinking/arch/const-96.htm, retrieved Sept. 11, 1997.

[227] Under terms of the Memorandum of Understanding (MOU) signed by the partners, AVIC controlled 46 percent of the joint venture, with Singapore Technologies holding 15 percent and AIA the remaining 39 percent.

[228] Pierre Sparaco, "Europeans, Chinese Terminate AE31X," *Aviation Week & Space Technology*, July 13, 1998, pp. 56-57.

[229] For more information on this project, see Chapter 5.

[230] Airbus Industrie News, Dec. 6, 1996, Airbus, found at Internet address http://www.airbus.com/newslong96.html, retrieved Sept. 11, 1997; and "Airbus/China MOU Signed," Air Transport World, found at Internet address http://www.atwonline.com/june1697.htm, retrieved Oct. 8, 1997.

[231] "Airbus/China: 100-Seater Makes Progress," Flug Revue Online, week of May 18, 1997, found at Internet address http://www.flug-revue.rotor.com/FRNews?FR970518.htm#AE100, retrieved Oct. 8, 1997.

[232] Paul Lewis, "Time Out in Asia," *Flight International*, Nov. 5-11 1997, pp. 38-40.

[233] Raytheon specializes in defense and commercial electronics, business aircraft, and construction and engineering. Raytheon Company, found at Internet address http://www.raytheon.com, retrieved

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1993, BAe's own aircraft production was limited to that manufactured for the two consortia under the AVRO and Airbus nameplates rather than its own line of aircraft. With the recent dissolution of the AI(R) consortium, however, BAe has again undertaken both the production and marketing responsibilities for the AVRO line of regional aircraft, and plans to launch an upgraded AVRO regional jet to enhance its market position.[234]

Fokker

Fokker Aviation BV, a Dutch military and commercial aircraft manufacturer, declared bankruptcy in March 1996 after nearly 77 years of operation. Fokker produced the Fokker 50 and 60 short-haul turboprops and Fokker 70 and 100 short- to medium-haul twin-jet aircraft, marketed as the Fokker JetLine. In the 14 years leading up to its 1996 bankruptcy, Fokker developed simultaneously two new aircraft (the Fokker 50 and 100) to replace its aging F27 and F28 aircraft after a cooperative arrangement with McDonnell Douglas for the production of a 132- to 138-seat airliner was terminated in February 1982. The so-called twin-track decision proved pivotal to Fokker's closure by taxing an inadequate development process and overextended resources during a period of adverse market conditions. Cost overruns, program delays, and the unprofitability of the two aircraft gradually eroded Fokker's financial condition and led the company to pursue several foreign investors before eventually declaring bankruptcy.[235]

Since the bankruptcy, Amsterdam-based Rekkof Restart has acquired many Fokker production resources with the goal of resuming Fokker 70 and 100 assembly.[236] The company reportedly has the financing and suppliers to initiate production of these aircraft, with first deliveries expected in spring 2000.[237]

European Aerospace Industry Integration

Although its restructuring is occurring independently of other regional aerospace issues, Airbus itself has become one of several elements of a broader attempt to develop an integrated European military/commercial aerospace industry that will compete more effectively with its U.S. counterparts. As Europe's leading LCA manufacturer, Airbus will likely be the focal point of European integration efforts. In response to a request from the partners' governments for an integration timetable, in March 1998 the partners generally agreed with the premise of a united European aerospace and defense company that could include other European industry participants, but raised many questions concerning time frame and procedural issues.[238] Although its specific

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[233] (...continued)
Oct. 20, 1998.

[234] Pierre Sparaco and Stanley W. Kandebo, "BAe Mulls Enhanced Regional Jet Aircraft," *Aviation Week & Space Technology*, May 25, 1998, p. 56.

[235] *Fifth Public Report of the Bankruptcy Trustees Pursuant to Section 73A Netherlands Bankruptcy Act*, Fokker, found at Internet address http://www.fokkernl.com/content/Indus973.htm, retrieved Nov. 12, 1997.

[236] Kate Sarsfield, "Shorts Removes Obstacles to Resumption of Fokker Production," *Flight International*, July 1-7, 1998, p. 4.

[237] "Bankrupt Aircraft Maker Fokker Tries Comeback Under New Name," *The European*, Sept. 14, 1998, found at Internet address http://newsedge, retrieved Sept. 15, 1998.

[238] John D. Morrocco and Michael A. Taverna, "Consolidation Plans Hinge on French Role,"
(continued...)

role has yet to be clearly defined, Airbus recognizes that this European integration will likely have some impact on its restructuring and future operations.[239]

Adoption of the Euro

In other measures to support European unity, many EU member governments will adopt the euro as a single European currency effective January 1, 1999. Although the full potential of the euro may eventually only be reached with U.S. dollar-euro parity, the euro could offer more immediate benefits. For example, with the elimination of exchange rates,[240] the euro will likely reveal cost differences between European companies and countries. More transparent pricing resulting from the euro adoption may heighten competition, which could contribute to European industry restructuring and other cost-cutting and efficiency measures. Consequently, euro pricing may ultimately enhance industrial competitiveness and influence purchasing patterns by allowing easier identification of the lowest price.[241]

Effects of U.S. and EU LCA Industry Structural Changes

Views of LCA Suppliers[242]

The Boeing-McDonnell Douglas merger has caused immediate fallout in the supplier industry by shrinking its customer base and eliminating business opportunities, particularly for those suppliers with strong links to McDonnell Douglas aircraft programs. The LCA duopoly will likely encourage further consolidation of the supply base, particularly in lower tiers, as suppliers follow strategies to strengthen their long-term market positions. Both U.S. and West European LCA suppliers are under pressure to reduce costs through such means as systems integration, supply chain management, and lean manufacturing, and are diversifying product and market ranges through mergers and other corporate alliances. European suppliers generally expressed more concerns regarding the risk of increasing supplier polarization between Airbus and Boeing, and the dangers to suppliers of vertical integration and preferred supplier arrangements. Although suppliers note that the restructuring of Airbus will likely improve its global competitiveness, restructuring appears to hold more long-run opportunities for those producers not already

[238] (...continued)
Aviation Week & Space Technology, Apr. 6, 1998, p. 22.

[239] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[240] Because aircraft prices are in U.S. dollars, Airbus will still be exposed to exchange rate risks. Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998. Airbus has reportedly asked Eurostat to develop an escalation formula in euros to be used for pricing aircraft contracts. Anton Joiner, "Airline Finance Markets Contemplate the Euro," *Commercial Aviation Report*, June 1, 1998, pp. 15-17.

[241] Nicholas Bray, "Euro Expected to Spell an End to Pricing Distortions," *The Wall Street Journal*, May 8, 1998.

[242] Based on USITC staff interviews with U.S., European, and Asian LCA suppliers and airlines, except as noted.

supplying Airbus programs with the development of any new aircraft programs and the potential to increase sourcing from nontraditional suppliers.

Although suppliers generally expressed a desire to work with both Boeing and Airbus, they noted that it is extremely difficult not to be stereotyped as either an Airbus or Boeing supplier. In fact, some suppliers indicated that the bipolar structure of the LCA industry has already forced suppliers to choose either Boeing or Airbus as a long-term strategic partner, thus pegging their success to the performance of one airframer. The loss of McDonnell Douglas as a customer has reduced opportunities for suppliers and contributed to a shift in the balance of power to the airframer since suppliers have fewer sources of business.

As a consequence, LCA suppliers are exploring risk-reduction strategies that lessen reliance not only on a particular airframer but on the LCA industry as a whole. Although many LCA suppliers are already diversified into other aerospace activities or markets, more diversification can be expected to stabilize businesses and offset LCA market cycles. Although suppliers may be interested in expanding into nonaerospace industries, most companies have a specialized knowledge of and experience in the aerospace sector that may not easily transfer to another industry or market.

Greater vertical integration and preferred supplier arrangements[243] are considered a direct outcome of the industry consolidation that develops from mergers such as that of Boeing and McDonnell Douglas. The two remaining airframers gain greater leverage in the airframer-supplier relationship and may be more interested in developing long-term linkages to guarantee an adequate parts supply, attractive pricing, and control of their supplier base. Although long-term contracts raise concerns regarding supplier initiative and cost competitiveness, other suppliers indicated that preferred supplier relationships would not reduce competitiveness if periodic competitive biddings were held to push suppliers to reduce costs and increase innovation.

In response to continued cost-reduction pressures, the LCA industry has turned to systems integration, supply chain management, and lean manufacturing as key methods to control costs. Systems integrators are becoming increasingly important to the LCA industry,[244] as airframers and airlines encourage suppliers to provide more complete aerospace systems to gain even greater efficiencies. This production approach enables airframers to pass along responsibility for design and financing of, and liability for, certain systems to their primary suppliers in an effort to push costs down the supply chain. For suppliers, systems integration provides opportunities to produce higher-valued components or systems and expand into new product areas, for example. As a consequence, some suppliers are merging to gain the critical mass necessary to finance the projects and systems desired by LCA manufacturers, or are creating partnerships and alliances that offer similar financial and technological advantages.[245]

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[243] Vertical integration is more common among lower-tier suppliers rather than LCA manufacturers, where risk-sharing partnerships and preferred supplier relationships are prevalent. U.S. industry official, telephone interview by USITC staff, June 24, 1998.

[244] "Supply Side Allies: It's Merge or Die for Many Aerospace Suppliers as the Industry Consolidates," *Puget Sound Business Journal*, June 19, 1998, found at Internet address http://newsedge, retrieved June 23, 1998.

[245] "Aerospace Best Practices: Conference Wrap-Up," *Aviation Week & Space Technology*, Feb. 16, 1998, p. S6.

Supply chain management is another highly complex task that has become a crucial business skill for prime contractors looking for ways to save costs. LCA manufacturers and their principal suppliers must balance the desire to cut their supplier base to reduce administrative costs and the need to encourage competition among suppliers to stimulate technological creativity and maintain a sufficient supplier base throughout the LCA business cycle. In addition, LCA suppliers are implementing lean manufacturing to gain cost reductions through manufacturing efficiencies and employee productivity. Enhanced overall operating potential resulting from these improvements will better position LCA component manufacturers in the highly competitive--and shrinking--industry.[246]

LCA engine manufacturers, a critical subset of the LCA supplier industry, may experience a shake-up if airframers offer fewer engines on newly developed aircraft. With the loss of McDonnell Douglas, only two Western LCA manufacturers are supporting the three major LCA engine makers and their cooperative engine ventures. Because engine makers are operating on thin margins in an intensely competitive market, the simultaneous development of several engine projects is often financially untenable. Moreover, the high costs associated with certifying additional engines for an aircraft may dissuade airframers from selecting more than one engine, despite the inherent competitive advantage of an aircraft with multiple engine choices. Airlines have expressed concern about the current engine/airframer relationship and the implications for future engine supply. Airlines generally prefer to have a choice of engines offered on an aircraft which then allows them to select that best suited to their fleet objectives.

Both airframers and engine manufacturers are demonstrating greater interest in owning and operating aircraft and engine maintenance and repair facilities worldwide. These overhaul facilities are viewed as a stable source of revenue that can offset the adverse financial impact of flagging aircraft and engine prices that are slow to cover product development and production costs. These manufacturers face competition in the repair business from airlines that have invested heavily in their own maintenance facilities as well as independent companies seeking to capitalize on this profitable business.

With respect to the restructuring of Airbus, suppliers generally expect the new organizational structure to improve competitiveness, but do not anticipate significant new opportunities to supply its current aircraft programs because of ongoing partner work-share arrangements. A history of unsuccessful bid competitions has also contributed to the pessimism of certain U.S. suppliers concerning future Airbus program chances. But because the SCE may expose Airbus to the discipline of the market and theoretically subsume nationalistic tendencies, some suppliers believe the restructuring may offer more contract possibilities, and simplify supplier relationships by having a single contact point.

Views of Airlines[247]

Although few airlines were major customers of McDonnell Douglas in recent years, the loss of that LCA producer has resulted in a notable airline emphasis on the need to have at least two fully competitive LCA producers serving the marketplace, in part to ensure competitive pricing levels,

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[246] Ibid., pp. S1-S6.

[247] Based on responses to USITC airline questionnaire, Feb. 1998; and USITC staff interviews with Asian, European, and U.S. airline officials, representing major and national airlines.

a full selection of aircraft, and LCA industry balance. Despite the cutback in suppliers, airlines have generally indicated that the consolidation will not likely affect their competitiveness vis-à-vis one another, particularly as technological developments appear to have plateaued. Operators of McDonnell Douglas aircraft indicated that their relationship with Boeing appears to be of similar--or better--caliber as that established with McDonnell Douglas. Future competition between the two airframers may occur in a more open environment with the transition of Airbus to the more transparent SCE structure.

Leading airlines report that any future adverse or beneficial effects resulting from the consolidation will likely impact all major airlines, providing no significant advantages to any one carrier, particularly as airlines encourage competition between the two airframers. Several operators noted, however, that it is still too soon to assess the full impact of the Boeing-McDonnell Douglas merger on their operations or the industry as a whole. Carriers did note that more participants in the LCA industry would provide more aircraft choices, better LCA pricing, and improved negotiating positions for airlines.

One area in which major world airlines have expressed divergent views regarding the effect of the LCA industry consolidation is its impact on future technological developments. While several carriers expect to see fewer new product developments because of the reduced level of competition at the airframer level, other airlines anticipate greater technological innovation and competition because of increased resource availability (e.g., more engineers, better LCA financial position). One carrier cited the importance of leverage in the airline/airframer relationship--if airlines have the greater leverage, they may be able to influence price levels and the pace of technological development through heightened LCA competition.

For operators of McDonnell Douglas aircraft, Boeing has committed its full support to the service and maintenance of these aircraft, and will keep the contractual commitments made by McDonnell Douglas. Two of these carriers, in fact, acknowledged that after-sales service has improved following Boeing's merger with McDonnell Douglas. One carrier also indicated that Boeing provides more favorable payment and delivery schedules than did McDonnell Douglas.

Airbus's shift to an SCE may produce a more open competitive environment. Airlines could gain noticeable benefits in terms of greater transparency in competitive biddings, as well as a less complicated, more responsive decision-making process with the implementation of a single customer interface. Several U.S. carriers expect higher aircraft prices to result from Airbus's restructuring and a more balanced market between Boeing and Airbus.

Implementation of the 1992 U.S.-EU Large Civil Aircraft Agreement

Overview

The Agreement Concerning the Application of the GATT Agreement on Trade in Civil Aircraft (the 1992 Agreement)[248] was drafted to strengthen provisions of the 1979 GATT Aircraft Agreement,[249] particularly those related to government subsidies. Such government support, related to the development and production of aircraft by Airbus with European Government involvement, had been the source of trade tensions between the United States and Europe. The 1992 Agreement seeks to reduce gradually the level of government support, and to prevent "trade distortions resulting from direct or indirect government support for the development and production of large civil aircraft...."[250]

Current Implementation Status

Subsequent to the agreement, multilateral negotiations began in October 1992 within the GATT Subcommittee on Trade in Civil Aircraft. Although several countries participated in the talks to expand the 1992 Agreement, ongoing disputes between the United States and the EU and the lack of support from other countries for a "support-based"[251] agreement contributed to the failure to add signatories to the agreement.

The EU and the United States also took opposing positions in another GATT forum where a new Agreement on Subsidies and Countervailing Measures was being crafted.[252] The EU supported the exclusion of the aircraft industry from this agreement, whereas the United States was interested in gaining complete coverage of the aerospace sector. After year-long negotiations, the two countries reached a compromise that brought the LCA industry into the final agreement, with certain exceptions to the subsidy disciplines. The more notable of these include an understanding that government subsidies to aircraft producers that exceed 5 percent of the development cost for

[248] See Appendix E for a copy of the 1992 Agreement and views of signatories.

[249] The 1979 Agreement requires the elimination of customs duties and other charges on civil aircraft; applies the provisions of the Standards Code to civil aircraft so that product standards will not create obstacles to trade or imported goods will be treated no less fairly than domestic products; requires that aircraft purchasers be free to select suppliers on the basis of commercial and technological factors, without any "reasonable" government pressure; and prohibits government application of quantitative restrictions of civil aircraft in a manner inconsistent with GATT. The most controversial aspect of the 1979 Agreement was its lack of clarity on subsidies issues, citing the need to repay subsidies if the aircraft were sold ("repayable subsidies"), and to apply the multilateral subsidies code to civil aircraft without providing further explanation. See U.S International Trade Commission, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft*, USITC publication 2667, Aug. 1993.

[250] Agreement Concerning the Application of the GATT Agreement on Trade in Civil Aircraft, p. 1.

[251] A "support-based" agreement would establish the conditions and use of government subsidies.

[252] The GATT Agreement on Subsidies and Countervailing Measures became effective on July 1, 1995.

a new aircraft will not constitute a presumption of serious prejudice[253] (i.e., such subsidies would be permitted). The other significant exception concerns royalty-based financing, the nonpayment of which would not constitute serious prejudice if the payment failure is due to the level of actual sales falling below the level of forecast sales.[254]

The Boeing-McDonnell Douglas merger exacerbated the conflict between the United States and the EU, prompting an EU request in April 1997 for a review of aircraft subsidies under the 1992 Agreement. The EU charged that the United States was not complying with its end of the agreement concerning limitations on indirect support provided through government-funded R&D. Boeing's subsequent concessions to the EC to gain approval of its merger with McDonnell Douglas helped to address EU concerns about indirect government support,[255] and averted a possible move by the EU to renegotiate or leave the agreement.

Implications for Competitiveness of the U.S. LCA Industry

The LCA industry will likely continue to undergo more structural changes as airframers and component manufacturers adjust to the price-competitive dynamics of the LCA market shaped by the merger of Boeing and McDonnell Douglas and the technological maturation of current aircraft. Airframers will likely continue to implement internal cost-savings efforts to improve competitiveness and financial performance, and will also demand cost reductions from and greater involvement of suppliers. Airframers may ultimately have to temper market share objectives at the expense of price competition to meet their need to earn a reasonable return to achieve reinvestment and profitability goals. Such a shift appears to be occuring,[256] which may result in a market that supports higher aircraft prices and relatively constant market shares as well as a stable supplier base. In the meantime, the pressure to reduce costs will likely drive Boeing and Airbus to pursue strategies that will continue to further supplier industry consolidation.

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[253] "Serious prejudice" refers to the adverse effects of one country's subsidy on another country's trade interests. The subsidy must be withdrawn or its adverse effects removed if a determination of serious prejudice is reached.

[254] *International Trade: Long-Term Viability of U.S.-European Union Aircraft Agreement Uncertain*, Government Accounting Office (GAO), Dec. 19, 1994, found at Internet address http://frwebgate.access.gpo.gov/cgi-bin/useftp.cgi?IPaddress=wais.access.gpo.gov&filename=gg95045.txt&directory=/diskb/wais/data/gaop. 38, retrieved Aug. 25, 1997, p. 38.

[255] See the section of this chapter on the Boeing-McDonnell Douglas merger for further information on the EU Commission competition review.

[256] Boeing and Airbus separately announced their intention to focus on increasing profitability rather than market share. Michael Skapinker, "Boeing and Airbus to End Struggle Over Market Share," *Financial Times*, Sept. 8, 1998; and Stanley Holmes and Jeff Cole, "Price War with Boeing Pares Profits at Airbus," *The Seattle Times*, Sept. 20, 1998, found at Internet address http://newsedge, retrieved Sept. 22, 1998. Boeing had previously announced a 5-percent increase in base prices. Polly Lane, "Analysts Doubt Impact of Boeing's Attempt to Raise Base Price of Airplanes," *The Seattle Times*, July 15, 1998, found at Internet address http://newsedge, retrieved July 16, 1998; and Jeff Cole, "Boeing Expects Upturn in Profits by Late 1999," *The Seattle Times*, July 23, 1998, found at Internet address http://newsedge, retrieved July 24, 1998. Airbus also announced a 3-percent price increase across its aircraft lines. Skapinker, "Boeing and Airbus to End Struggle Over Market Share."

Boeing's competitive position in this market hinges on its ability to smooth post-merger integration and stabilize LCA manufacturing during the window of opportunity that has developed as Airbus resolves internal struggles and postpones its SCE transition date. Although its strengthened defense sector will help to offset the cyclicality of the LCA industry and bolster shareholder value and financial performance, Boeing's more diverse operations and ongoing integration difficulties may hamper its flexibility and focus on the LCA sector. The current strong price competition places even greater importance on Boeing's ability to fully implement its manufacturing and process improvements in a timely fashion. If future market demand warrants, Boeing may also need to refocus on aircraft technology, an area in which its acquisition of McDonnell Douglas will likely help. However, the many demands on Boeing's financial and managerial resources may detract from its ability to pursue future R&D and program developments that the LCA market may demand.

Airbus, as an SCE, could be a more formidable, business-oriented competitor, particularly if it is able to fully implement the new structure, take advantage of its opportunities, and capitalize on the missteps of its major competitor. The challenges for Airbus will be to participate thoroughly in all aspects of the marketplace and eventually move beyond the SCE to a more typically constructed public company, which could be a model for an integrated European aerospace industry. Although Airbus will gain numerous operating efficiencies and greater responsiveness with a single management voice, ongoing intracorporate and national disputes may constrain enhanced competitiveness in the short term by limiting component outsourcing and capital availability. Such restrictions inhibit Airbus's ability to gain the best aircraft components at the best price, choose appropriate market access strategies, and amass greater funding for future projects. Moreover, although the adoption of the euro may eventually provide more clear-cut price comparisons among its European suppliers, it is unclear whether Airbus will be free to shift sourcing to lower cost suppliers.

Although opportunities exist for both airframers to increase sales to former McDonnell Douglas operators, Airbus may benefit from airlines' efforts to encourage competition and support a balance between the airframers. In terms of the development of new aircraft and technologies to meet future market demand, neither airframer appears to have an obvious competitive edge. Both companies could be hampered by various financial limitations, particularly if profitability continues to suffer under the current pricing scenario. Boeing has continually demonstrated its capacity to develop and launch market-driven aircraft, and the shift to an SCE structure may enhance Airbus's market responsiveness in this regard.

Both airframers are currently seeking to exploit opportunities in the 100-seat and 500-seat markets, but with somewhat different strategies. Although the 100-seat regional niche holds promise, Boeing has yet to capitalize on this market with its purpose-built 717-200. The restrained response to this aircraft reflects pricing concerns and airline uncertainty as they consider the relative advantages of all available aircraft options, which may provide an opening for the proposed Airbus market entry. In the case of the 500-seat aircraft avidly pursued by Airbus, the market has yet to develop sufficiently and may require a longer-term view. Boeing has taken a more cautious approach by evaluating a larger, less-costly derivative of its 747. Airbus must ultimately add a long-range, large-capacity aircraft to its lineup to better compete with Boeing since its A340 stretch derivatives appear to leave much of the lucrative 747 market intact. Boeing will likely retain its dominance of the long-range, high-capacity market for the short to medium term while Airbus seeks to develop further the business case for the A3XX.

New business opportunities for the U.S. LCA supplier industry are not expected to increase, in part because of the loss of McDonnell Douglas and the lack of new program developments. With few, if any, new LCA customers and sales prospects in the short to medium term, further consolidation and diversification may be expected as manufacturers seek to reduce risk and achieve greater economies of scale and systems integration capabilities. Moreover, Boeing's long-term linkages with suppliers and Airbus's traditional preference for sourcing from member country's suppliers may point to greater industry polarization. These strategies not only exclude many suppliers from sales opportunities over long periods but also increase suppliers' stake--particularly those of smaller, less diversified suppliers--in the performance of its major LCA customer, be it either Airbus or Boeing. For chosen suppliers, however, such commitments facilitate long-term business planning and adequate returns on investment in support of a healthy supply base. Increased outsourcing and production offsets designed to improve market access will also affect U.S. suppliers. Boeing may have greater short- to mid-term flexibility than Airbus to effect such market-access strategies, and could gain aircraft sales accordingly. The benefits of such sales to suppliers, however, will accrue to those already locked into production contracts for the chosen aircraft.

CHAPTER 4
CHANGES IN THE STRUCTURE OF THE RUSSIAN LARGE CIVIL AIRCRAFT INDUSTRY

Overview

The Russian large civil aircraft (LCA) industry has devoted all available resources during the last 10 years to develop a new generation of LCA capable of competing on the global market with aircraft from The Boeing Co. (Boeing) and Airbus Industrie, G.I.E. (Airbus). Due to a number of factors, the most critical being a lack of capital and a corporate structure that is not market oriented, Russian producers are not expected to be in a position to secure global market share with their new generation aircraft in the next 10 years.[257]

After providing background information on the evolution of the Russian LCA industry since the breakup of the Soviet Union and current industry structure, the chapter assesses the Russian industry's potential to compete in the global market based on the determinants of competitiveness discussed in Chapter 2. Finally, the chapter addresses implications of changes in the structure of the Russian LCA industry on the competitiveness of the U.S. LCA industry.

Background

Before 1992, the military and civil aviation industries in the former Soviet Union were wholly state owned and strictly regulated. Design bureaus were separate entities from serial production facilities where aircraft were mass produced. The government decided which LCA designs would go forward, provided funding for the entire development and production process, and dictated how many aircraft would be produced annually. Moreover, major components, such as engines, were selected by design bureaus without competitive bidding by suppliers. This system allowed for overcapacity in the manufacturing industry, did not provide incentives for technological and production process improvement, and did not foster design improvements in LCA, leaving the industry ill prepared to function in a market-oriented manner.

[257] Even with access to vast amounts of capital, establishing a position as a supplier of LCA to the world's airlines evolves over the course of decades. Airbus Industrie, a consortium with significant financial resources and partners that have extensive aerospace manufacturing experience, notes that after 28 years in business, it still does not offer a complete LCA product range. The company states that it takes a long time for new participants to become full-fledged members of the global industry. Transcript of hearing for USITC inv. No. 332-384, Mar. 17, 1998, p. 10.

In the mid-1980s, the Soviet Union began to shift its traditional military focus to developing new civil aircraft. These new civil programs were intended to upgrade the domestic civil air transportation network, generate hard currency through products for export, and convert defense production facilities and employment to civil ventures.[258] However, after the dissolution of the Soviet Union, the Russian civil aircraft industry nearly collapsed. Since 1991, the 80-percent decline in civil aircraft production has led to idle facilities, forced vacation or part-time employment for 40 percent of the work force, delayed payment of wages,[259] and a loss of 50 percent of the industry's technical specialists.[260]

During 1992-97, the Russian Government issued a series of decrees to buoy the Russian aerospace industry, including:

- the maintenance of import tariffs,
- the creation of a leasing mechanism for Russian-built aircraft,
- the development of an air code for the Russian Federation,
- the demonopolization of the air transport industry,
- the granting of desirable air routes to operators of new Russian aircraft,
- the reduction of value-added taxes on Russian-made aircraft,
- the regulation of government-controlled ground support service prices,
- the granting of investment tax credits on federal taxes,
- the granting of loan guarantees and the acceptance of loans from the U.S. Export-Import Bank and the European Bank for Reconstruction and Development, and
- the provision of government support for certain aviation entities.

However, the missions and purview of various government ministries and agencies have been in flux since 1992, prompting regulatory and budgetary uncertainties.[261] Most state policy decrees have not been implemented, particularly those requiring government funding.[262]

In September 1997, the Russian Government issued a major plan for the aerospace industry titled "Concept of Restructuring the Russian Aviation Industry Complex." As characterized by the Russian Ministry of Economy, the plan has three principal facets: 1) design bureaus and serial production facilities should be united to reflect a market-driven industry; 2) the network of state-owned research institutes should be restructured to maintain technical skill levels while eliminating redundancy; and 3) cooperative arrangements with foreign partners should be developed. The realization of these objectives could have a significant positive effect on the competitiveness of the

[258] Dennis L. Holeman, *The Structure of the Civil Aviation Industry in the Former Soviet Bloc Countries*, SRI International, Business Intelligence Program, Dec. 1991, p. 1.

[259] Wages in this industry are approximately 50 percent of the average industrial wage in Russia.

[260] Alexander Gerashchenko, "Russian Aircraft Industry Sounds the Alarm," *Aerospace Journal*, Nov.-Dec. 1997, p. 10.

[261] Aerospace Committee of the American Chamber of Commerce in Russia, *Barriers to Aviation/Aerospace Investment in the Russian Federation*, Aerospace White Paper Rewrite One, Oct. 3, 1995, found at Internet address http://www. online.ru/sp/accr/aero/aero1.html, retrieved Sept. 4, 1997. Since the breakup of the Soviet Union, oversight of the civil aviation industry has been alternately the responsibility of the Ministry of Industry, the Ministry of Defense Industries, the Ministry of the Economy, and is expected to be moved to the Ministry of Industry and Trade, which is currently being created.

[262] Gerashchenko, "Russian Aircraft Industry Sounds the Alarm," p. 11.

Russian LCA industry. However, the Ministry of Economy stresses that industry restructuring and streamlining is strictly voluntary, with no incentives or government guidance to be provided.[263] Without Russian Government intervention, little action is likely to be taken by the industry; it is unlikely that design bureaus and production facilities would agree upon a single industry consolidation plan.

There are currently three major Russian LCA concerns--Ilyushin Aviation Complex Joint Stock Company (Ilyushin), Tupolev Joint-Stock Company (Tupolev), and Joint Stock Company A.S. Yakovlev (table 4-1). However, only Ilyushin and Tupolev have designed models for Western certification and sale on the global market. These three companies have a long history of designing a wide range of civil and military aerospace products, and approximately 90 percent of their LCA in service belongs to airlines of the former Soviet Union and the Commonwealth of Independent States. Other markets for these LCA are primarily former Soviet bloc and developing countries.

Table 4-1
Russia: Russian LCA industry

Design bureau and year founded	Affiliated LCA production facilities	LCA models in the world fleet[1]		Aircraft type	Production status
Ilyushin Aviation Complex Founded: 1933	Chkalov (Tashkent,Uzbekistan) Voronezh (Russia)	Il-62:	170 in world fleet none on order	4 turbofan long-range airliner	Out of production
		Il-76:	427 in world fleet none on order	4 turbofan medium/long-range freight transport	Production at Chkalov
		Il-86:	91 in world fleet none on order	4 turbofan wide-bodied passenger transport	Out of production
		Il-96:	8 in world fleet 32 on order	4 turbofan wide-bodied passenger/cargo transport	Production at Voronezh
Tupolev Joint-Stock Company Founded: 1922	Aviastar (Ulyanovsk, Russia) Kazan (Russia) Aviacor (Samara, Russia)	Tu-134:	406 in world fleet none on order	2 turbofan short/medium-range transport	Out of production
		Tu-154:	728 in world fleet 5 on order	3 turbofan medium-range transport	Production at Aviacor
		Tu-204:	6 in world fleet 38 on order	2 turbofan medium-range airliner	Production at Ulyanovsk and Kazan
Joint Stock Company A.S. Yakovlev Founded: 1927	Saratov (Russia)	Yak-40:	779 in world fleet none on order	3 turbofan short-haul jet transport	Out of production
		Yak-42:	149 in world fleet 4 on order	3 turbofan short/medium-range passenger transport	Production at Saratov

[1] As of August 1997. Includes passenger and cargo variants. Information compiled from “World Airliner Census,” *Flight International*, Oct. 15-21, 1997.

Source: Compiled from various sources by USITC staff.

[263] Russian Ministry of Economy official, interview by USITC staff, Moscow, Mar. 31, 1998.

Competitive Assessment

For its domestic market, the Russian LCA industry must now build cost-efficient aircraft that will appeal to newly profit-oriented airlines. Sales to domestic airlines represent a critical first step toward sales to foreign customers, providing capital required to finance the production and certification of models for export. Export aircraft at the very least must meet Western standards in terms of quality, lifecycle, and operating efficiencies, and must be able to be serviced and supported globally.

The Ilyushin Il-96 (table 4-2) and the Tupolev Tu-204 (table 4-3) represent a point of departure for the Russian LCA industry. Both were relatively new designs at the time of the breakup of the Soviet Union and were chosen to represent the modernization of the domestic civil aviation industry by aiming to meet Western standards in terms of operating costs, reliability, and airworthiness requirements. However, these programs have run into serious funding problems, resulting in major delays.

Table 4-2
Russia: Ilyushin new generation LCA

Model	Debut	Range[1]	Passenger capacity	Engines	Avionics	Certification status	Western competitors[2]
Il-96-300	First flight (prototype) 9/88	4,050-5,940	235 - 3 class 300 - 1 class	4 Aviadvigatel PS-90A (Russian)	Russian	Russian: 12/92	Created for domestic market
Il-96M passenger	First flight 4/93	6,195	312 - 3 class 335 - 2 class 375 - 1 class	4 Pratt & Whitney PW2337 (U.S.)	Rockwell Collins (U.S.), Litton (U.S.), Smiths (U.K.)	Russian: Expected 1999	Boeing 777 Airbus 330
Il-96T freighter	First flight 5/97	2,807	Max. payload 92,000 kg	4 Pratt & Whitney PW2337 (U.S.)	Rockwell Collins (U.S.), Litton (U.S.), Smiths (U.K.)	Russian: Preliminary 3/98 Full expected early-mid 1999 FAA (U.S.): Expected soon after full Russian certification	Boeing 747-400F MD 11F

[1] Range expressed in nautical miles.
[2] The most commonly referred to Western competitors. For a detailed presentation of all possible competitors, including models no longer in production, please refer to Appendix F.

Source: Compiled from various sources by USITC staff.

Table 4-3
Russia: Tupolev new generation LCA

Model	Debut	Range[1]	Passenger capacity	Engines	Avionics	Certification status	Western competitors[2]
Tu-204-100 Based on Tu-204: Announced in 1983, first prototype flight 1/89.	First flight 1/87	1,565	184 - 2 class 200 - 1 class 212 - High density	2 Aviadvigatel PS90-AT (Russian)	Russian Honeywell (U.S.) IRS optional	Russian: 1/95	Created for domestic market
Tu-204-120 (Reference to the -120 series includes the -120 and -122)	First flight 1993	2,500	184 - 2 class 200 - 1 class 212 - High density	2 Rolls-Royce RB211-535E4 (U.K.)	Russian Honeywell (U.S.) IRS optional	Russian: Passenger 12/97 Cargo 3/98 JAA (West European) expected late 1999 (cargo); passenger variant by mid-2000.	Boeing 757 Airbus A321
Tu-204-122	Program not yet finalized	2,500	196 - 2 class 210 - 1 class	2 Rolls-Royce RB211-535E4 (U.K.)	Honeywell (U.S.) (Bendix/Allied Signal (U.S.) avionics are optional on -121 model)	N/A	Boeing 757 Airbus A321
Tu-204-200 (aka Tu-214) (Combi)	First flight 3/96	3,415	16 containers and 30 passengers 6 containers and 130 passengers 18 LD3s only	2 Aviadvigatel PS90-A (Russian)	Russian	Russian: Expected 3/97; delayed	Unknown
Tu-204-220	Program not yet finalized	In excess of 3,415 (Exact range not available)	184 - 2 class 200 - 1 class 212 - High density	2 Rolls-Royce RB211-535E4 or -535F5 (U.K.) or Pratt & Whitney PW2240 (U.S.)	Russian	N/A	Unknown
Tu-204-222	Program not yet finalized	In excess of 3,415 (Exact range not available)	184 - 2 class 200 - 1 class 212 - High density	2 Rolls-Royce RB211-535E4 or -535F5 (U.K.)	Honeywell/ AlliedSignal (U.S.)	N/A	Unknown

Table 4-3
Russia: Tupolev new generation LCA--*Continued*

Model	Debut	Range[1]	Passenger capacity	Engines	Avionics	Certification status	Western competitors[2]
Tu-204-320 (aka Tu-224)	Announced 1994	3,585 3,885	160 - 1 class (short- and mid-range model) 166 - 1 class (long-range model)	2 Rolls-Royce RB211-535E4 (U.K.)	Russian Honeywell (U.S.) optional	Not certified	Certain Boeing 737 Next Generation models Airbus A319 IGW Airbus A320-200 IGW
Tu-204-300 (aka Tu-234)	Roll out 8/95	1,295	166 - 1 class	2 Aviadvigatel PS90-P (Russian)	Russian or Western	Russian: Projected late 1998; not on schedule	Unknown
Tu-334-120	First flight projected in 2000	1,268	72 - 2 class 102 - 1 class	2 BMW Rolls-Royce BR710-48 (German-U.K. joint venture)	Honeywell (U.S.)	N/A	Boeing 717-200 AVRO RJ70
Tu-334-200	After the Tu-334-120	1,187	110 - 2 class 126 - 1 class	2 BMW Rolls-Royce BR715-58 (German-U.K. joint venture)	Honeywell (U.S.)	N/A	AVRO RJ100

[1] Range expressed in nautical miles.
[2] The most commonly referred to Western competitors. For a detailed presentation of all possible competitors, including models no longer in production, please refer to Appendix F.

Source: Compiled from various sources by USITC staff.

The question of Russia's competitive potential is difficult to answer in light of the fact that its new generation aircraft with Western engines and avionics--the Il-96M/T and the Tu-204-120 series--have not yet been flown by commercial airlines. The first delivery of the Il-96T is expected in January 1999,[264] and the first delivery of the Il-96M a year later.[265] The first delivery of the Tu-204-120 was scheduled for May 1998, but Russian tariffs on the aircraft's foreign content and VAT tax on the entire aircraft made it too expensive for the Russian airline that was scheduled to take delivery.[266] The first two Tu-204-120s--one passenger aircraft and one freighter--were delivered to Air Cairo (Egypt) in fall 1998. The airline plans to begin charter service with these aircraft before the end of 1998.[267]

[264] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998.
[265] Ilyushin Aviation Complex official, interview by USITC staff, Moscow, Mar. 30, 1998.
[266] "Lufthansa Looks at Cargo Version of Tu-204," *Flight International*, June 17-23, 1998, p. 12.
[267] The aircraft are leased from Sirocco Aerospace International. *Speednews*, Nov. 6, 1998.

With this background in mind, the competitive potential of the Russian LCA industry will be assessed based on four distinct determinants of competitiveness: availability of capital, industrial and demographic characteristics, corporate characteristics, and program characteristics.

Availability of Capital

The ability to raise capital is the single largest obstacle facing the Russian LCA industry today. As described in Chapter 2, large sums of capital are required to introduce new programs, conduct research and development, expand production facilities, procure inputs, certificate aircraft, and establish a global after-sales support network. Capital is also critical for getting products to market rapidly once the design is final and first orders are taken.[268] Capital deficiencies in the Russian LCA industry are of such a magnitude that LCA companies cannot meet even their most basic needs, such as worker salaries. Financing for LCA production in Russia faces obstacles that may not be overcome without the creation of a legal framework and the reform of tax structures.

Currently, Tupolev's financial situation is more dire than Ilyushin's. Tupolev has made little progress in restructuring its debt, and the new director general of the company reportedly plans to make fiscal reform a priority.[269] The company is currently months behind in paying salaries, and reportedly is leasing some of its buildings to raise cash.[270] Its principal production factory in Ulyanovsk has over 90 percent of its work force on indefinite leave,[271] and the Kazan factory stopped paying workers in September 1997.[272] While Ilyushin reportedly pays its design bureau employees on time[273] and has no debt to the state,[274] sources in Russia report that the Voronezh

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[268] While Boeing was able to get the 757-200 certificated 4 years after the design was finalized, Tupolev took 10 years to get the Tu-204 certificated by Russian authorities after the design was finalized. Boeing did have a slight advantage in that the 757-200 fuselage cross section was derived from the 707, 727, and 737. Under the Soviet system, Russian LCA typically took 7 years to move from the design phase to first flight; production aircraft were not delivered for another several years. Paul Jackson, ed., *Jane's All the World's Aircraft 1997-98* (Surrey, UK: Jane's Information Group Limited, 1997); and Paul Duffy and Andrei Kandalov, *Tupolev: The Man and His Aircraft* (Warrendale, PA: Society of Automotive Engineers, 1996).

[269] U.S. Embassy, Moscow, information provided to USITC staff, June 24, 1998.

[270] Russian industry expert and consultant, interview by USITC staff, Moscow, Mar. 27, 1998.

[271] Foreign Broadcast Information Service (FBIS) Daily Report, "Russia: Plight of Ulyanovsk Plane Makers Highlighted," FBIS-SOV-98-155, Moscow Russian Television, June 4, 1998. FBIS is a U. S. Government office chartered to monitor foreign (non-U. S.) open source information for use by the U.S. Government.

[272] FBIS Daily Report, "Russia: Ailing Kazan Aircraft Plant Profiled," FBIS-SOV-98-048, Moscow Russian Television Network, Feb. 17, 1998.

[273] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

[274] FBIS Daily Report, "Russia: Russian Minister on Anniversary of Ilyushin Aviation Center," FBIS-SOV-98-086, Moscow ITAR-TASS, Mar. 27, 1998.

production facility is operating on a part-time basis,[275] owes 543 billion rubles to the state,[276] and has not paid employees on the Il-96 production line since late 1997.[277]

While Ilyushin officials report that they have finally secured the remaining financing necessary for production of both the Il-96M and Il-96T,[278] press reports indicate that the withdrawal of state guarantees in 1997 resulted in the uncertainty of complete financing for the Il-96M.[279] Further, U.S. industry sources report that state guarantees that were pending in 1998 have been put on hold as a result of the current economic crisis in Russia.[280] As of late 1997, funding obtained for the Tu-204-120 series was barely one-third the amount ultimately needed;[281] the program's leading foreign investor reportedly has agreed to provide Tupolev with necessary funding to put the program back on track.[282]

Governmental Sources

In the absence of significant private capital infusions, government support of the Russian LCA industry is required. Such support may come from the Russian Government or foreign governmental lending institutions. Since the breakup of the Soviet Union, any funding of aircraft programs by the Russian Government has generally been provided months after it was pledged, at which point the allotted funds already were significantly devalued.[283] In the most recent years, funds for the aerospace industry allocated in the annual Russian federal budgets have rarely been disbursed at all.

Foreign governmental financial institutions are a potentially important source of capital for the Russian industry; however, they only satisfy a small portion of what is required. The U.S. Export-Import Bank (Ex-Im) can grant loans to support U.S. content on Russian aircraft, and the U.S. Trade and Development Agency (TDA) can offer grants and loans for program feasibility studies. For example, on the Il-96M/T program, Ex-Im made a preliminary commitment of $1 billion to finance the U.S. content. While this commitment expired in early 1997, Ex-Im continued to work with involved parties (e.g., European Bank for Reconstruction and Development and Russian banks) to finalize the financing details and present a package proposal to the Ex-Im board for approval. However, as a result of the current economic crisis in Russia, Ex-Im has temporarily suspended renewal of the preliminary commitment. TDA provided partial funding in the amount

[275] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998.

[276] FBIS Daily Report, "Russia: Kiriyenko To Induce Airlines to Buy Russian," FBIS-SOV-98-218, Moscow RenTV Television, August 6, 1998.

[277] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998.

[278] Ilyushin Aviation Complex official, interview by USITC staff, Moscow, Mar. 30, 1998.

[279] Vovick Karnozov, "Boeing Captures Russian Market," May 4, 1998, *AeroWorldNet - This Week in Russian Aerospace*, found at Internet address http://www.aeroworldnet.com/lra05048.htm, retrieved May 8, 1998.

[280] U.S. industry official, telephone interview by USITC staff, Nov. 12, 1998.

[281] Michael A. Taverna, "Civil Aircraft Outlook Improving in Russia," *Aviation Week & Space Technology*, Sept. 8, 1997, p. 54.

[282] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998; and Michael A. Taverna, "JAA Bemoans Pace of Tu-204 Certification," *Aviation Week & Space Technology*, June 1, 1998, p. 40.

[283] Duffy and Kandalov, *Tupolev*, pp. 174-5.

of $1 million for studies on coproduction of the Il-96M/T.[284] In addition, Honeywell has applied for Ex-Im financing for engineering costs, start-up costs, and U.S. content on the Tu-334, and TDA has provided partial funding for a study on the coproduction of the Tu-334 with Honeywell avionics.[285] The TDA-funded study will be used by Ex-Im in its review of the application for Tu-334 financing. To date, no European funding has been secured for the Tu-334 program; however, some Ukrainian Government support may be made available if the aircraft is assembled in Kiev.[286] For the Tu-204-120 program, Rolls-Royce has initiated discussions with the Export Credits Guarantee Department, the export credit agency of the United Kingdom, for export credit support of the U.K. content of the aircraft.[287]

Financial Markets

The Russian LCA industry has not received significant commercial capital infusions. Banks face great risks when investing in Russian industries in general, perhaps more so when investing in the inherently risky LCA industry. The yield on such investments does not compare favorably with the returns on state securities,[288] so capital is being funneled to the government rather than to private industry.[289] Moreover, prime interest rates in Russia for borrowed capital are exorbitant.[290]

One new source of capitalization for the Russian LCA industry comes from the developing pattern of commercial investors financing the production and subsequent leasing of a specific number of aircraft.[291] Two large Russian banks, Inkombank and Menatep, have joined forces to finance the production of two Tu-204 aircraft. These aircraft are to be delivered in November 1998 and March 1999 to the leasing company Inkom-avia (created under Inkombank), with Menatep providing financial assistance in the lease agreement. Menatep and Inkombank are seeking participation from other Russian banks, the Russian Government, and foreign partners.[292]

Another entity involved in Russian LCA production and lease financing is Sirocco Aerospace International (Sirocco). This joint venture is led by the Egypt-based Kato Group, and also includes the Aviastar manufacturing facility and its marketing agency, Aviaexport. Sirocco was created to promote the Tu-204-120 series aircraft, and combines capital from financial markets--Citibank provides lease financing--and foreign commercial investment from the Kato Group.

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[284] U.S. Government official, information provided to USITC staff, Mar. 1998.
[285] Ibid.
[286] "Regional Review - Russia and the CIS," address of Paul Duffy, Director, Irish Aviation Authority, delivered to the International Society of Transport Aircraft Trading (ISTAT) Conference, Boca Raton, FL, Mar. 16, 1998.
[287] Rolls-Royce official, fax communication to USITC staff, August 5, 1998.
[288] FBIS Daily Report, "Russia: FIGs Seen as Engine for Economic Growth," FBIS-SOV-98-086, Moscow Nezavisimaya Gazeta, Mar. 27, 1998.
[289] Russian industry expert and consultant, interview by USITC staff, Moscow, Mar. 27, 1998.
[290] Before the recent financial crisis in Russia, these rates were approximately 40 percent. This compares with a prime rate in the United States of approximately 8.5 percent, with corporate rates generally 1-2 percent lower.
[291] For a discussion of aircraft leasing in Russia, see the section on "Domestic Market" in this chapter.
[292] FBIS Daily Report, "Russia: Menatep, Inkombank to Help Aircraft Building Industry," FBIS-SOV-98-149, Moscow ITAR-TASS, May 29, 1998.

Although Sirocco and Citibank have brought significant resources to the Tu-204-120 series--approximately $100 million through late 1998--the program continues to founder.[293]

Foreign Commercial Investment

Foreign capital sources are generally reluctant to invest in the Russian LCA industry because of the unknown value of Russian aircraft and the uncertain domestic market for those aircraft. This hesitancy has been reinforced by Russia's reluctance to share corporate control with foreign investors, thereby inhibiting wider foreign financial participation. Low levels of foreign investment preclude the Russian LCA industry from receiving important capital infusions, as well as benefiting from technology transfer.

Investment barriers such as frequently changing tax laws, inconsistent customs regulations and customs duties, and burdensome certification and licensing requirements inhibit the flow of private foreign investment capital into the Russian LCA industry.[294] A U.S. source reports that investment in Russia will continue to be minimal until the Russian Government approves a new and transparent tax code and enacts laws to encourage and protect foreign investment.[295] The United States and Russia are working toward ratification of a treaty to encourage protection of foreign investment, and are also working toward preparation and implementation of new standards to harmonize Russian accounting and auditing rules.[296]

The Russian Government, in an effort to preserve its domestic LCA industry, passed the "Russian Federal Law on State Regulation of the Development of Aviation," effective January 14, 1998. According to U.S. industry sources, this law will likely have a negative impact on the Russian LCA industry by stifling foreign involvement, thus depriving the industry of much needed capital and expertise.[297] Although the law stipulates preferential treatment such as tax holidays and guarantees on investment for Russian and foreign investors in aviation-related research and manufacturing ventures, it sets a 25-percent limit on the share of foreign capital in aviation enterprises and requires that the senior officials and management staff be Russian citizens.[298] Unlike the many decrees and proclamations with respect to the Russian aviation industry that are rarely implemented, these restrictions on foreign investment are law and are expected to be strictly enforced.[299] The law does not affect arrangements finalized before that date, however, grandfathering in two important U.S. investment projects.[300] U.S. industry sources have expressed strong views against these restrictions.

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[293] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998.

[294] Aerospace Committee, *Barriers to Aviation/Aerospace Investment*.

[295] Gary G. Yerkey, "Russia: Russia's Offer to Join WTO 'Falls Short' of Requirements for Entry, U.S. Aide Says," *BNA International Trade Daily*, article No. 50921005, Apr. 2, 1998.

[296] U.S. Department of Commerce telegram, "Report on May 9 U.S.-Russia Business Development Committee Meeting, May 11 Commercial Signing Ceremony, and Text of BDC Joint Statement (Part 2 of 2)," message reference No. 01482, Washington, DC, Apr. 1998.

[297] U.S. industry sources, interviews by USITC staff, Washington, DC and Moscow, Jan.-Apr. 1998.

[298] Office of the United States Trade Representative, *1998 National Trade Estimate Report on Foreign Trade Barriers*, p. 351.

[299] U.S. industry official, interview by USITC staff, Moscow, Apr. 3, 1998.

[300] These include Pratt & Whitney's investment in Perm Motors, and General Electric's investment in Rybinsk Motors. U.S. industry officials, interview by USITC staff, Washington, DC, Jan. 27, 1998.

Industrial and Demographic Characteristics

Design and Engineering Capabilities

Design and engineering capabilities are the leading competitive advantage of the Russian LCA industry, bolstered by a highly educated engineering population and large state-run research and test facilities. Russian aerodynamic research and testing skills reportedly are excellent,[301] and the Russian industry possesses a core competency in systems integration,[302] a critical factor in producing LCA. More specifically, the Russian industry has extensive experience in landing gear design and manufacture.

However, problems persist in terms of cost and timeliness of aircraft development. Russia's design and engineering capabilities are tempered by a lack of computerization in many facets of aircraft design.[303] Further, low wages and their delayed payment that have resulted in a significant loss of highly educated designers and scientific personnel in the Russian LCA industry.[304] While Russia has developed advanced skills in titanium alloy processing, because there is no patent system in Russia, there is little sharing of technology between industries; thus, the Russian aircraft industry reportedly is only beginning to research and use certain light-weight materials[305] such as composites. Although joint research and engineering projects with Western LCA entities may prove beneficial to the Russian LCA community, providing access to and training on such Western design tools as computer-aided design equipment, these newly acquired skills may be lost without large-scale updating of research facilities and design bureaus.

Design and engineering capabilities with respect to critical components--engines and avionics--are not world-class due to the former Soviet approach to the design and production of these systems and a current lack of capital to invest in these sectors. Russian engines were traditionally developed under the "safe-life" philosophy, meaning that no systems will fail, but that part life is defined and systems are not repairable, necessitating relatively frequent engine replacement. In a nonmarket economy, the short wing life of Russian engines was not a cause for concern; rather, it maintained employment levels. According to a top Ilyushin official, Western-made engines and avionics continue to outperform their Russian counterparts in terms of dependability and service life.[306] Russian officials associated with the engine industry report that engine development has improved in recent years with more extensive use of computer modeling and modular assembly, and that engine designers and manufacturers are striving for better operating characteristics while

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[301] "Minister: Russian Technology Equal to American, European," found at Internet address http://www.newsedge, Aug. 14, 1997.

[302] U.S. industry official, interview by USITC staff, Washington, DC, Jan. 28, 1998.

[303] Jacques Delys and Ernest Weiss, *The Aviation Industry in the Former Soviet Union* (Paris: ID Aéro, May 1997), p. 28.

[304] U.S. industry officials, interview by USITC staff, Washington, DC, Jan. 27, 1998.

[305] Russian industry expert and consultant, interview by USITC staff, Moscow, Mar. 27, 1998.

[306] Igor Katyrev, "Ilyushin Aircraft on the Global Market," *Aerospace Journal*, Mar.-Apr. 1998, p. 13. Russian engine maker Perm currently is upgrading its PS-90 LCA engine, using Western parts and components, to better the engine's time between overhauls, which is currently 1,000-5,000 hours. Western engines typically log 20,000 hours between overhauls. Nicolay Novichkov, "Perm Focused on PS-90 Upgrade," *Aviation Week & Space Technology*, July 6, 1998, p. 58.

retaining high safety standards.[307] Russian sources state that before the breakup of the Soviet Union, avionics were developed by the state according to military specifications; now Russia lacks funding to develop appropriate, competitive civil avionics.[308] Competition among suppliers for contracts now exists, but, in general, traditional design bureau-supplier relationships continue. Moreover, any existing incentives for suppliers to design more efficient equipment are tempered by financial constraints to improve design and production capabilities.

Both Boeing and Airbus have contributed to the maintenance and further development of design and engineering capabilities in Russia. Boeing has made such contributions through joint-venture arrangements, contract purchases, and Memoranda of Understanding (MOU) between the company and the Ministry of the Economy. The most recent MOU was signed in June 1998 and concerns scientific and technical developments in which approximately 40 Russian aerospace companies and scientific research institutes are involved.[309] Since 1992, the Boeing Technical Research Center has cooperated with Russia's preeminent research institutes,[310] and a new Engineering Design Center in Moscow was inaugurated in June 1998.[311] Airbus reached a cooperation agreement signed with the Ministry of the Economy in August 1997,[312] and participates in the European-Russian Aircraft Consortium, founded in February 1998 to coordinate cooperation between Airbus and Russian entities.[313]

Manufacturing Infrastructure

Lack of sufficient demand from an undercapitalized domestic airline industry and the relatively small export market for Russian aircraft currently precludes improvement of Russian production lines and prevents the Russian LCA industry from achieving economies of scale. The Russian industry does benefit from a manufacturing infrastructure that is well established, including state-run research institutes, design centers, production facilities, parts suppliers, and test facilities; however, most of these facilities are aging and are not outfitted with modern equipment. The two facilities primarily responsible for the manufacture of the new generation Russian LCA, Voronezh and Ulyanovsk, are the country's newest and most modern, albeit less modern than most of the facilities of Western producers.

The Voronezh Aircraft Joint Stock Company, affiliated with Ilyushin, is currently one of the largest LCA production facilities in Russia. It was built in the late 1960s, and was outfitted with

[307] Central Institute of Aviation Motors officials, interview by USITC staff, Moscow, Mar. 30, 1998.
[308] Aeroflot-Russian International Airlines official, interview by USITC staff, Moscow, Mar. 31, 1998.
[309] FBIS Daily Report, "Russia: Government 'Satisfied' With Boeing Cooperation Plan," FBIS-SOV-98-163, Moscow Segodnya, June 12, 1998.
[310] Aerospace Committee, *Position Paper*, "Member Activities with Russian Aerospace Partners" section, p. 8.
[311] PRNewswire, "Boeing Celebrates Anniversary with New Design Center in Moscow," *The Boeing Company*, press release, June 9, 1998.
[312] Prehearing submission of Airbus Industrie of North America, USITC inv. No. 332-384, Mar. 6, 1998, p. 32.
[313] Consortium members include Aviastar, Tupolev, Gidromash (landing gear manufacturer), NIIAT (Scientific Research Institute of Aviation Technology and Industrial Engineering), and TsAGI (Central Aero-Hydrodynamics Institute). FBIS Daily Report, "Russia: Airbus Industrie, European-Russian Consortium Sign Accord," FBIS-SOV-98-141, Moscow Interfax, May 21, 1998.

modern equipment of that time.[314] The Ulyanovsk Aviation Industrial Complex 'Aviastar' facility, affiliated with Tupolev, was constructed during 1975-85. The factory is the newest and best equipped in Russia, with computer-driven design capability and computer-controlled manufacturing processes with dedicated software. Both of these facilities are certified by the U.S. Federal Aviation Administration (FAA) to produce aircraft for sale in the United States; however, this does not automatically confer certification to the aircraft they produce.[315] Most other LCA facilities in Russia were built in the 1930s and do not compare well with their more modern Western counterparts, particularly with respect to computerized equipment.[316]

The Russian civil aircraft industry does not have a healthy and reliable domestic supplier industry;[317] partnerships with Western firms may be an important first step toward improving the domestic supplier base.[318] Moreover, the use of Western engines and avionics on the new generation of Russian LCA will likely diminish the competitive disadvantage to Russian LCA manufacturers resulting from the lack of a competitive domestic supplier industry. Some Russian component prices are higher than world prices,[319] but more importantly, Russian airframers report that suppliers do not meet delivery and certification deadlines.[320] One source in Russia reports that a major problem for the Tu-204 program is that many of the program's Russian suppliers have virtually ceased operations.[321] Russian suppliers acknowledge that they have quality problems, but low production rates reduce the incentive to invest in equipment and processes that will alleviate these problems. Additionally, Russian suppliers require full, up-front payment from airframe manufacturers,[322] putting further strain on Russian airframers, given the lack of sufficient capital availability.

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[314] "Ilyushin Aviation Complex" brochure, presented by Ilyushin officials, interview by USITC staff, Moscow, Mar. 30, 1998.

[315] See section on "Certification of Aircraft" for more information on this process.

[316] Delys and Weiss, *The Aviation Industry*, p. 28.

[317] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

[318] Perm Motors, the leading Russian supplier of LCA engines to the domestic industry, will reportedly approve a company reorganization that would permit the creation of a long-planned cooperative venture with Pratt & Whitney. Pratt & Whitney began negotiating in 1993 to set up ventures aimed at jointly developing and marketing aero and industrial derivatives of Perm's PS-90A engine. Pratt & Whitney currently holds 25.1 percent of Perm Motors stock. With respect to avionics, Russia's State Scientific Research Institute for Aviation Systems (GosNIIAS), the leading developer of military and civil avionics in Russia, has set up a joint laboratory with Rockwell Collins to develop and verify software codes for several major avionics systems of the Il-96. Under a coproduction arrangement, GosNIIAS will assemble and test components of Collins' Traffic Alert and Collision Avoidance System (TCAS) for commercial airline use for sale by Collins throughout the world. Collins reportedly is also supplying components to Cheboksari Equipment-Building Factory, which will build two avionics computers for the Il-96M/T, designed at GosNIIAS. In addition, AlliedSignal participates in the American Russian Integrated Avionics joint venture with GosNIIAS for developing avionics suites, and Honeywell has licensed assembly of its inertial reference systems to Russian avionics producer RPZ.

[319] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

[320] "It is a Competition of Wealth Rather Than Aircraft," *Aerospace Journal*, Mar.-Apr. 1998, p. 9.

[321] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998.

[322] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

Domestic Market Conditions

Although a large population base and a need for fleet renewal exist, Russian airlines are not currently able to make large purchases of domestic-built LCA. In general, the presence of a large domestic market for LCA is a competitive strength for LCA manufacturers. Domestic airlines act as launch customers, testing the reliability and value of an aircraft before the company establishes the parts and support network necessary for export. Moreover, income from sales to domestic airlines contributes to the finance of production and certification of models for export. This competitive advantage is contingent, however, upon the financial condition of these airlines and their ability to acquire domestic LCA.

Prior to the breakup of the Soviet Union, Aeroflot-Soviet Airlines (Aeroflot) was the single Soviet national airline. Currently there are more than 300 airlines in Russia, 141 of which are independent, including the reorganized Aeroflot-Russian International Airlines (ARIA). Approximately 40 airlines are certified international carriers. Although the overall number of new airlines has grown markedly since 1992, most airlines are undercapitalized and debt ridden, and many have just a single aircraft in their fleets.[323] Moreover, the decline in airline passenger-miles since 1990 has been dramatic,[324] owing largely to increasing airfares, declining incomes, unsafe aviation conditions,[325] and periods of political unrest in certain localities. The need for industry consolidation is recognized; the Russian Government's March 1998 "Concept for Reform and Development of Civil Aviation" suggests that 315 Russian airlines may be consolidated through voluntary alliances, resulting in 5-8 federal airlines, 20-25 regional airlines, and 60-70 local carriers.[326] Consolidation may contribute to an improvement in the overall health of the Russian airline industry, thereby increasing LCA demand.

Whereas formerly the Russian LCA industry was guaranteed a certain level of revenue from sales to the government-controlled Aeroflot, Russian aircraft must now compete with Western aircraft. Western aircraft are offered with more flexible financing and leasing options, whereas Russian manufacturers require up-front payment in full for their aircraft. Moreover, Western aircraft are more reliable and efficient to operate. Since 1991, approximately 30 Western LCA have been leased by Russian airlines, with another 20 to 25 on order for lease. In 1997, ARIA ordered 10 new Boeing 737 aircraft for delivery in 1998, marking the first purchase of non-Russian aircraft by a Russian airline.[327] Sources report that current purchase orders for Russian LCA by Russian airlines include 17 Il-96M and 3 Il-96T aircraft for ARIA, 6 firm and 6 option orders for the Il-96M by Transaero Airlines, and 4 firm orders for the Il-96M from Vnukovo Airlines.[328] The reportedly poor operating economics of the Il-96T have led to some speculation about whether

[323] About 35 airlines transport approximately 75 percent of total passenger traffic in Russia. "Aeroflot and Transaero: A Comparative Study," *Markets Russia*, June 12, 1997, p. 1, found at Internet address http://www.skate.ru/sampl/97-22/tx-copro.html, retrieved Dec. 17, 1997.

[324] In 1990, 90 million passengers flew in the Russia region of the Soviet Union; by 1997, this number had dropped to 25.5 million passengers. Duffy, "Regional Review," address to ISTAT Conference.

[325] These include lack of governmental oversight, the aging fleet, poor aircraft maintenance, and the overloading of aircraft.

[326] FBIS Daily Report, "Russia: Details of Civil Air Reform Concept Noted," FBIS-SOV-98-091, Moscow Russkiy Telegraf, Apr. 1, 1998.

[327] U.S. Government official, fax communication to USITC staff, June 15, 1998.

[328] U.S. aerospace company representative, interview by USITC staff, Moscow, Apr. 3, 1998.

ARIA will take all 20 aircraft;[329] however, a $1 billion contract between ARIA and Voronezh for the 20 Il-96M/T aircraft was signed in late July 1998.[330] Tupolev reportedly has 15 orders for the Tu-204-120 series, all from airlines in the former Soviet Union and the Middle East.[331]

The acquisition and operation of Western aircraft could generate income necessary for Russian airlines to remain operational and become profitable. While these airlines have been encouraged by the state to purchase Russian LCA, the priority for these airlines is to build a capital base by utilizing the most efficient LCA currently available to them. For example, ARIA reports that it needs Western-built aircraft in the short term to maintain and expand its position in the international air transport market, but that it plans to convert its fleet during the next 10-15 years to Russian-built aircraft such as the Il-96M/T.[332]

However, the Russian LCA industry has strongly opposed the influx of Western LCA into Russia, and has lobbied the Russian Government to maintain burdensome tariffs and taxes on imported LCA. This is despite a 1996 joint MOU between the United States and Russia, in which the Russian Government agreed to grant tariff waivers to enable Russian airlines to meet their needs with U.S. and other non-Russian aircraft on a nondiscriminatory basis.[333] During summer 1998, the Russian Government began drafting a resolution that would reduce tariffs on foreign aircraft from 30 to 20 percent. Foreign aircraft that have no Russian-made counterparts would be eligible for a further tariff reduction to 5 percent. If an airline seeks to have tariffs waived entirely on a foreign aircraft, it must commit to buying Russian aircraft in an amount equal to three times the amount of tariff duties waived. This will require entering into an agreement with the Ministry of Economy which specifies the type of Russian aircraft to be purchased and over what period of time. The government reportedly will consider, on a case-by-case basis, tariff waivers sought on a foreign-built aircraft for which there is a Russian competitor.[334]

Despite a tremendous need to renew the Russian LCA fleet, deliveries by Russian manufacturers have plunged, due in large part to the absence of financing and leasing mechanisms for the purchase of Russian aircraft. The creation of a domestic leasing mechanism would provide Russian airlines access to new Russian-built aircraft at more affordable terms; however,

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[329] Karnozov, "Boeing Captures Russian Market."

[330] FBIS Daily Report, "Russia: Russia's Aeroflot to Buy 20 New Il-96MT Airliners," FBIS-SOV-98-209, Moscow NTV, July 28, 1998; and FBIS Daily Report, "Russia: Kiriyenko Welcomes Aeroflot Investment Agreement," FBIS-SOV-98-209, Moscow ITAR-TASS, July 28, 1998. In October 1998, it was reported that the Il-96T prototype would arrive shortly in Voronezh for 6 months of design modifications, and fabrication of the second of these aircraft had not yet begun. "Voronezh Near Bankruptcy," *Aviation Week & Space Technology,* Oct. 26, 1998, p. 13.

[331] Michael A. Taverna, "JAA Bemoans Pace of Tu-204 Certification," *Aviation Week & Space Technology*, June 1, 1998, p. 40.

[332] Nicolay Novichkov, "Aeroflot Moves Ahead With Fleet Expansion," *Aviation Week & Space Technology*, Apr. 20, 1998, p. 39.

[333] Office of the United States Trade Representative, *1998 National Trade Estimate Report*, pp. 350-351.

[334] U.S. Department of State (USDOS) telegram, "GOR Begins to Clarify Position on Market Access for Foreign-Origin Aircraft," message reference No. 018469, U.S. Embassy, Moscow, July 1998.

significant legal and tax barriers hinder the formation of a leasing mechanism in Russia.[335] Once these barriers are remedied, leasing companies may initially need significant government-authorized loan guarantees to make large purchases from Russian airframers. The Russian Government reportedly earmarked $800 million in the 1997 budget for a state-sponsored leasing program, but the funds were never made available.[336] Currently, because Russian Government guarantees on leasing loans for Russian LCA cover only up to 40 percent, it costs significantly more to lease an Ilyushin Il-96 than a Boeing 777-- $1.2 million and $800,000 per month, respectively.[337] While guarantees of up to 85 percent were promised for 1998,[338] they were not provided.[339]

Despite the lack of financing and leasing mechanisms in Russia, some entities are attempting to initiate Russian aircraft production financing and leasing activity. Among them are Inkom-avia, created jointly by Russian bank Inkombank and the Central Aero-Hydrodynamics Institute, for the all-Russian Tu-204 (2 on order); Sirocco Aerospace International, for the Tu-204-120 series (30 on order with 170 options); the Russian Aviation Consortium, involved in leasing all-Russian Tu-204s through Moscow International Aviation Leasing (20 on order); and the multinational conglomerate American International Group, which signed on as a lessor of IL-96M/T aircraft in late 1997 (20 on order).

Corporate Characteristics

Corporate Structure

The corporate structure of the Russian LCA industry continues to reflect the Soviet-era system of unintegrated design bureaus and production facilities, resulting in disjointed and inefficient operations. The most severe competitive disadvantages resulting from the absence of a streamlined corporate structure are reduced access to capital, diminished internal decision-making capabilities, and inhibited ability to get products to market. In addition, Russian LCA manufacturers are largely unable to interface with airlines with a minimum amount of inconvenience for the customer and maximum internal efficiency.

The evolution from state-controlled, unintegrated design bureaus and production facilities to a more integrated design and production structure has been slow. Most of the design bureaus and production factories have been privatized, and are now joint-stock companies, or limited companies. The second step has been the emergence of financial-industrial groups (FIGs), which are meant to be transitional organizations that help industries restructure in the face of shrinking capital, orders, and government support. FIGs are loosely based on a central industrial enterprise

[335] Mark Long, “Financing the Russian Aviation Industry,” *Aerospace Journal*, Mar.-Apr. 1997, p. 54.

[336] U.S. and Foreign Commercial Service and USDOS, “Russian Aviation Industry,” Industry Sector Analysis series, Dec. 30, 1997, p. 17.

[337] “It is a Competition,” p. 9. Since the residual value of Russian aircraft is unknown, lenders want to recoup as much of the full value of the aircraft as possible during the leasing period. Higher government guarantees would decrease lenders’ exposure to risk.

[338] FBIS Daily Report, “Russia: Reasons Given for Using Foreign Planes,” FBIS-SOV-98-128, Moscow Novyye Izvestiya, May 8, 1998.

[339] Russian industry expert and consultant, telephone interview by USITC staff, Oct. 7, 1998.

and a group of associated companies which may or may not contribute to production of a single output, but generally have a central managing board.[340] The Ilyushin Financial-Industrial Group, comprising the Ilyushin Aviation Complex, the Voronezh Aircraft Joint-Stock Company, and the Tashkent Aircraft Production Facility was founded in July 1995; the Russian Aviation Consortium FIG, established by Presidential Decree in May 1995, brings together holdings in Tupolev, Aviastar, Perm Motors, and Aviadvigatel Aircraft Engine Companies, Promstroybank, and the Federal Industrial Bank, and has a majority stake in Vnukovo Airlines and Murmansk Airlines.

The next step in creating a more market-oriented corporate structure is to unite the design bureaus and affiliated production facilities into one holding company that could operate like a Western corporate entity. According to an Ilyushin official, the current Russian law on holding company formation is not adequate. The current law reportedly calls for participants to contribute only 10 percent of their equity; a revised law providing that the lead company hold controlling stakes in the subsidiaries and fully supervise their operations is a necessary component in the restructuring of the Russian industry.[341]

The current amount of friction between design bureaus and production facilities is an obstacle to the integration and consolidation of the Russian LCA industry. A major source of this friction is control. Design bureaus had been preeminent under the traditional system. Today, production facilities are the revenue generators and are demanding more control over the development and production process.[342] Moreover, conflicts among regions within Russia emerge because no region that is home to a production facility wants to relinquish control over final assembly.[343]

Recently, members of the Ilyushin FIG have been linked more formally as a joint-stock holding company; according to an Ilyushin official, establishment of this holding company was delayed for a number of years because of the legal inadequacies on holding company formation.[344] Despite this more streamlined corporate structure, however, the members continue to operate as distinct, remotely connected entities.[345] The Tupolev Holding Company would comprise the Tupolev Joint-Stock Company, Aviastar (Ulyanovsk production facility), and the Kazan Aircraft Production Association; while Tupolev officials predicted in April 1998 that the President would sign the implementing legislation imminently,[346] as of October 1998 this still had not occurred. Tupolev and its associated production facilities are far less integrated than Ilyushin and its associated factories. Aviacor, a production facility once closely associated with Tupolev, currently has the most tenuous connection to the design bureau. Aviacor officials have indicated that it will not be part of the Tupolev Holding Company.[347]

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[340] Government financial benefits are supposed to accrue to FIGs but have not been forthcoming due to budgetary restraints. USDOS telegram, "IMI - Demystifying Russian FIGs: Banker Barons vs. Industry-Led Financial Industrial Groups," message reference No. 023163, prepared by U.S. Embassy, Moscow, Sept. 1997.

[341] "It is a Competition," p. 9.

[342] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

[343] Russian Ministry of Economy official, interview by USITC staff, Moscow, Mar. 31, 1998.

[344] "It is a Competition," p. 9.

[345] Russian industry expert and consultant, telephone interview with USITC staff, July 6, 1998.

[346] Tupolev Joint-Stock Company official, interview by USITC staff, Moscow, Apr. 1, 1998.

[347] Aviacor Joint Stock Company/Aviacor International official, interview by USITC staff, Samara, Russia, Apr. 2, 1998.

From the airlines' perspective, communication problems between design bureaus and production facilities cause difficulties for customers.[348] Even sales to ARIA are difficult, because the airline does not want to deal separately with designers and manufacturers.[349] For a foreign airline that expects the level of cooperation and service provided by Boeing or Airbus, this would be unacceptable.

Market Analysis Capabilities

In general, Russian aircraft producers have little experience with market analysis, marketing expertise, and product and customer support.[350] Those in decision-making positions still tend to be engineers and designers by trade, and have received little or no training in marketing and business development. As a result, decisions often overlook the needs of LCA customers. For example, in a recent interview, the General Director of Ilyushin stated that he believes that the best system would be for the design bureaus to submit designs to state research institutes, which should bear the responsibility for deciding which projects meet Russian and international standards, and thus which projects should go forward.[351] This approach does not seem to incorporate market research, nor would it foster market-oriented competition within the Russian LCA industry.

According to ARIA, the Il-96M was developed in the late 1980s without input from Aeroflot, the only domestic airline at that time, and Aeroflot was not consulted early enough on the Tu-204 program; consequently, the airline disapproves of certain aspects of both programs. ARIA reports that some lessons have been learned, and that Tupolev has consulted with ARIA on the Tu-334 program.[352] A Boeing official has noted that Russian LCA industry interest in "understanding the commercial aspects of aviation business" is increasing.[353] In addition, Russian engine and avionics producers reportedly are beginning to conduct market research in an effort to better serve Russian airlines.[354]

Arrangements with Foreign Aerospace Entities

Arrangements with established members of the global LCA industry, including joint research, joint production, subcontracting, and joint ventures, could serve as important vehicles for the Russian LCA industry, providing needed capital and expertise to aid in the transformation from a centrally planned to a market-driven industry. Moreover, despite the fact that some Western equipment is

[348] Ibid.

[349] "It is a Competition," p. 9.

[350] Dennis L. Holeman, *Can the Civil Aircraft Industry in the Former Soviet Bloc Countries Participate in the World Market?* SRI International, Business Intelligence Program, Feb. 1992, pp. 5-7.

[351] "It is a Competition," p. 9.

[352] Aeroflot-Russian International Airlines official, interview by USITC staff, Moscow, Mar. 31, 1998.

[353] Vovick Karnozov, "Interviews with Boeing Executives in Russia," *AeroWorldNet This Week in Russian Aerospace*, found at Internet address http://www.aeroworldnet.com/lra06228.htm, retrieved June 23, 1998.

[354] Aeroflot-Russian International Airlines official, interview by USITC staff, Moscow, Mar. 31, 1998.

significantly more expensive than Russian equipment,[355] Russian airframers have recognized the benefits of incorporating Western-made subassemblies--in particular, engines and avionics--into their aircraft. The use of Western engines will reduce fuel burn, improve reliability, and better meet international standards than current Russian engines. Western avionics systems have a reputation for being more reliable, and typically incorporate Traffic Alert and Collision Avoidance System (TCAS)[356] technology, which is required on aircraft flying into the United States, Australia, and the European Union.[357] Should Russian LCA break into nontraditional export markets in any significant way, it will almost certainly be with models incorporating Western engines and avionics.

Western partners are interested in participating in the Russian industry primarily to gain market access to both the aerospace industry and other sectors in Russia. U.S. involvement is most evident in Ilyushin's Il-96 program while European involvement is focused on Tupolev's Tu-204 program.[358] While the prospects for mutually profitable joint programs were bright at the beginning of the decade, in general U.S. companies state that their experience has been discouraging, largely because of the financial condition of Russian partners and the inability of the Russian Government to provide needed assistance.[359] With respect to joint production and subcontracting, the process of receiving Russian certification for foreign LCA inputs is time-consuming, expensive, and nontransparent. U.S. sources report that Russian standards are applied inconsistently, and foreign-owned firms perceived as having "deep pockets" may be treated differently with respect to cash outlay, as Russian agencies responsible for certification use the process as a fund-raising venture.[360]

Perceived Image of Manufacturer

The Russian LCA industry's lack of a track record selling and servicing proven aircraft to market-oriented airlines is a serious competitive disadvantage. Airlines from around the world express

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[355] A Russian-made Aviadvigatel PS-90 engine reportedly cost $3.3 million in early 1997, compared to $5 million before Russian taxes for a similar Pratt & Whitney engine. Jeff Grocott and Jim Vail, "Can Russian Aircraft Producers Fight Back?" *St. Petersburg Times,* Oct. 28-Nov. 3, 1996; and U.S. industry official, information provided to USITC staff, Apr. 9, 1998.

[356] TCAS is installed in commercial jets to search for and alert pilots to the presence of other aircraft. More advanced versions of TCAS also advise pilots on actions to take to avoid aircraft that are getting too close.

[357] Grocott and Vail, "Can Russian Aircraft Producers Fight Back?"

[358] Pratt & Whitney supplies the engines for the Il-96M/T, Rockwell Collins supplies the avionics, Boeing has provided certification seminars, and the FAA is currently conducting a certification program for the Il-96T. Rolls-Royce supplies the engine for the Tu-204-120 series, a joint venture between Rolls-Royce and BMW is to supply the engine for the Tu-334, and Airbus is providing technical assistance for European certification of the Tu-204; this aircraft is likely to receive European certification prior to U.S. certification. Western avionics for these Tupolev aircraft, however, are of U.S. origin.

[359] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

[360] Aerospace Committee, *Barriers to Aviation/Aerospace Investment.*

skepticism about the viability of Ilyushin and Tupolev as global LCA suppliers.[361] Moreover, airlines indicate that Russian aircraft have a reputation for poor quality and substandard after-sales support, and airlines anticipate negative passenger perceptions about flying in Russian aircraft. Finally, since the resale value of Russian LCA is unknown, a prospective purchaser faces considerable uncertainty in performing a lifetime cost/benefit analysis of the aircraft.[362]

Program Characteristics

Certification of Aircraft

The ability to produce LCA that meet global safety and noise standards and can therefore be certificated by Western aviation authorities is a formidable task, both technologically and financially. Lack of funding has caused major delays in Russian, FAA, and European Joint Aviation Authorities (JAA)[363] certification for both Ilyushin and Tupolev. Such delays lengthen the time it takes to get new LCA to market, resulting in lost sales.

Before applying for certification with U.S. and European authorities, a de facto requirement for flying in most international markets, Russian aircraft must be certified by the Russian airworthiness authority, the Aviation Register. This is a costly process involving hundreds of required test flights. The Il-96T received preliminary Russian certification on March 31, 1998, and Russian certification for the Il-96M is expected in 1999.[364] The Tu-204-120 (with Russian avionics) received Russian certification for the passenger version in December 1997, and for the cargo version in March 1998;[365] the Tu-204-122 version with Western avionics is still under development, but will undergo an abbreviated process as a result of certification of the -120.[366]

To export aerospace products to Western markets, Russian manufacturers must obtain airworthiness certificates from the major Western certification agencies for both their production facilities and products. It can take as long as 2 years to certify a production facility.[367] Ulyanovsk and Voronezh are the only Russian plants currently certified by the FAA[368] and neither have been certified by the JAA.[369]

[361] Compiled from responses to USITC airline questionnaire, Feb. 1998; and U.S. airline industry officials, telephone interviews by USITC staff, Oct. 1998.

[362] Ibid.

[363] The JAA coordinates certification activities in Western Europe, but certificates of airworthiness and the certification process itself is under the purview of national civil aviation authorities. A recent EU regulation has required all EU countries to join JAA, adopt all of JAA's Joint Airworthiness Requirements, and accept imported products certified by JAA without additional technical conditions.

[364] U.S. industry official, information provided to USITC staff, Apr. 9, 1998.

[365] U.S. industry official, e-mail communication to USITC staff, July 31, 1998.

[366] Russian industry expert and consultant, telephone interview by USITC staff, July 6, 1998.

[367] Russian Interstate Aviation Committee official (retired), interview by USITC staff, Moscow, Mar. 26, 1998. This process has been somewhat shorter for factories in other, nontraditional LCA-producing countries. U.S. industry official, information provided to USITC staff, July 15, 1998.

[368] Russian industry expert and consultant, interview by USITC staff, Moscow, Mar. 27, 1998.

[369] German national authorities reportedly have toured the facilities at Ulyanovsk and gave them a positive preliminary report. Russian industry expert and consultant, telephone interview by USITC staff, July 6, 1998.

To obtain FAA and JAA certification for its aircraft, Russia must first establish bilateral aviation safety agreements (BASAs) with these authorities.[370] Negotiation of these agreements and the subsequent implementing rules is a lengthy process; an MOU between Russia and the United States on technical cooperation was signed in 1995, and final BASA negotiations began in March 1998. A limited BASA is expected to be in place by the end of 1998.[371] This BASA will allow the FAA to ensure that the Russian Aviation Register can apply U.S. standards and correctly certificate aircraft for flight in the United States.[372] The Il-96M/T is the "shadow certification" aircraft for FAA certification of aircraft in its class, meaning that the FAA follows Russian authorities through their certification process in order to understand and evaluate their procedures.[373]

The FAA is working with Ilyushin on the Il-96 program, and the JAA has begun preliminary work with Tupolev on the Tu-204 program. FAA certification for the Il-96T is expected in November 1998,[374] after modifications for certain FAA equipment requirements are met.[375] The Tu- 204-120 series is likely to be the first Russian aircraft to undergo JAA type certification.[376] The protocol to begin the certification process was signed in 1997, but the process has been delayed because of funding problems, failure on the part of Tupolev to provide requisite documents, and JAA difficulties in assessing the Russian certification system.[377]

Purchase Price and Operating Costs

The new generation Russian LCA are priced significantly lower than their Boeing and Airbus counterparts (table 4-4), and the incorporation of Western engines and avionics may make important improvements in operating costs when compared to all-Russian models. These improvements, combined with low purchase prices, may provide for niche sales to smaller airlines outside the Russian LCA industry's typical customer base, and a few sales of cargo aircraft to some major carriers.[378] Low purchase price, however, likely will not be incentive enough for the world's major airlines to invest in Russian passenger LCA.

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[370] Holeman, *Can the Civil Aircraft Industry*, p. 8.

[371] Taverna, "JAA Bemoans Pace of Tu-204 Certification," p. 40.

[372] U.S. Federal Aviation Administration official, interview by USITC staff, Moscow, Apr. 3, 1998.

[373] U.S. Federal Aviation Administration official, interview by USITC staff, Moscow, Apr. 3, 1998.

[374] U.S. industry official, information provided to USITC staff, Apr. 9, 1998.

[375] The Il-96M/T aircraft is not currently equipped with a stall-warning stick shaker, and the windshield post is wider than FAA requirements permit. U.S. industry officials, interview by USITC staff, Jan. 27, 1998.

[376] Taverna, "Civil Aircraft Outlook Improving in Russia," p. 55.

[377] Taverna, "JAA Bemoans Pace of Tu-204 Certification," p. 40.

[378] Lufthansa reportedly considers the Tu-204-120 cargo version to be an aircraft in which it may have a long-term interest. "Lufthansa Looks at Cargo Version of Tu-204," *Flight International*, June 17-23, 1998, p. 12.

Table 4-4
Russia: Russian and Western LCA purchase prices

Wide-bodied LCA		Narrow-bodied LCA	
Model	**Price**	**Model**	**Price**
Il-96M/T	$75 million	Tu-204-120	$36-38 million
Boeing 777	$128-170 million	Boeing 757	$61-86 million
Airbus A330/340	$109-158 million	Airbus A321	$45-58 million

Source: Compiled from various sources by USITC staff.

In one study of comparative operating costs,[379] under certain parameters, the Tu-204-120 series has 18-27 percent lower fuel, maintenance, and finance seat-mile costs than the A321, and 27-30 percent lower costs than the 757. This is largely due to a lease rate for the Tupolev aircraft that is only two-thirds that of its competitors.[380] However, the study acknowledges that the Tu-204-120 series does not benefit from commonality with other aircraft, causing the plane to lose some of its direct operating cost advantage over the A321 and 757. Strictly in terms of fuel burn, the Tu-204-120 series is 7 percent higher than the 757 and 58-60 percent higher than the A321. Moreover, with a maximum fuel load, the Tu-204-120 series does not have the same range as the 757. No operating cost comparisons are available for the Il-96M/T. However, according to the general director of ARIA, the Il-96T will not offer competitive operating economics, resulting in low profitability prospects.[381]

Product Line and Commonality[382]

It is a distinct competitive disadvantage that Ilyushin and Tupolev will not offer a wide range of aircraft certified for flight in most international markets. The new generation of Russian LCA basically consists of one aircraft from each manufacturer--the Il-96 and the Tu-204. Ilyushin officials report that they are not interested in producing LCA with fewer than 200 seats, and do not want to design a plane larger than the Il-96, offered at a maximum of 375 seats.[383] This business strategy would likely put Ilyushin at a competitive disadvantage vis-à-vis Boeing and Airbus which offer families of aircraft spanning a broad range of seating capacities. Airbus notes

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[379] See Charles Williams and Paul Duffy, “The 757's Test of Strength,” *Aircraft Economics*, Mar.- Apr. 1997, for a detailed analysis of this operating cost comparison, including pertinent analysis parameters.

[380] The Tu-204-120 will be leased by Sirocco Aerospace International, which has established a dedicated subsidiary to arrange industry-standard operating lease packages. Sirocco’s primary banker and financial adviser in the project is Citibank. Since the leasing company is not in need of state-guaranteed credits from Russian commercial banks, this aircraft is available with competitive lease rates.

[381] Alexander Velovich, “Ilyushin Freighter Efficiency Fails to Impress Aeroflot Director,” *Flight International*, Apr. 1-7, 1998, p. 4.

[382] As discussed in Chapter 2, commonality refers to the use of common features, parts, and systems in the aircraft produced by an LCA manufacturer. Development cost and production efficiencies accrue to the LCA manufacturer through this strategy, while operating cost efficiencies accrue to airlines with more of such aircraft in their fleets.

[383] Ilyushin Aviation Complex official, interview by USITC staff, Moscow, Mar. 30, 1998.

that, although it has been producing LCA for the global market for 28 years, its product line still does not cover the entire LCA seating range of 100 to more than 400 seats.[384]

Despite commonality being a factor that affects purchasing decisions for the world's leading airlines, it is a relatively new concept for Russian LCA manufacturers. However, recent efforts to take advantage of commonality are evident in both Ilyushin and Tupolev's future product plans. Ilyushin's proposed Il-98, a twin-engined version of the Il-96, would reportedly incorporate equipment and systems found on the Il-96, but the program is semidormant due to a lack of funding.[385] In its Tu-334 program, Tupolev is incorporating many wing similarities from the Tu-204, and is using the same but shortened fuselage and the identical flight deck.[386] Moreover, the use of Western engines and avionics on Russian LCA will provide some commonality for airlines whose fleets include Western LCA with this equipment.

Global Support Network

Russia's ability to sell its aircraft in the world market will depend heavily on its ability to provide product support. However, Russian producers cannot provide adequate after-sales support and service, and flight simulators and systems trainers are not conveniently located.[387] To be globally competitive, Russian producers will have to form cooperative agreements with a range of Western support and service firms to perform parts distribution, documentation, maintenance, repair, overhaul, painting, interior installation, customization, and conversion.[388]

Thirteen aircraft repair centers in Russia have become public companies, with 11 of them having made the transition to joint stock companies. However, the equipment at these facilities is considered to be substandard, and certification guidelines are only now being formulated.[389] While these facilities are beginning to repair aircraft off site, as opposed to repairing aircraft only at their repair facility,[390] a tremendous gap remains between the capabilities of these facilities and their Western counterparts. Russian industry officials acknowledge that Western engine manufacturers realize a significant competitive advantage from their worldwide service networks.[391]

Because of these factors, Ilyushin plans to subcontract support services to a third party, likely a non-Russian company, and is looking for foreign partners for parts depots.[392] However, sources report that these efforts have not progressed very far because of financial constraints.[393] Sirocco is demanding a spare-parts support package from Tupolev for its order for Tu-204 aircraft, which

[384] Transcript of hearing for USITC inv. No. 332-384, Mar. 17, 1998, p. 10.

[385] Russian industry expert and consultant, interview by USITC staff, Moscow, Mar. 27, 1998.

[386] Jackson, ed., *Jane's 1997-98*, pp. 466-67.

[387] Western producers offer simulators and trainers in several centers around the world; Russian producers only maintain centers in Russia.

[388] Holeman, *Can the Civil Aircraft Industry*, p. 9.

[389] Gennady Gipich, "Russia Solves Aircraft Repair Problems," *Aerospace Journal*, Nov.-Dec. 1997, p. 44.

[390] Ibid., p. 45. While Boeing and Airbus aircraft generally can be completely repaired at or near the location where they became disabled, Russian aircraft typically must be repaired enough to fly them to a specified repair site, where more extensive repairs can be performed.

[391] Central Institute of Aviation Motors officials, interview by USITC staff, Moscow, Mar. 30, 1998.

[392] Ilyushin Aviation Complex official, interview by USITC staff, Moscow, Mar. 30, 1998.

[393] Representatives of U.S. aerospace companies, interview by USITC staff, Moscow, Mar. 26, 1998.

it plans to subsequently lease, and Lufthansa Technik reportedly has agreed to support the plane.[394]

Implications for the Competitiveness of the U.S. LCA Industry

Russian LCA producers are not likely to be in a position to secure global market share in the next 10 years, thereby having virtually no effect on the competitive position of the U.S. LCA industry during that time frame. Notwithstanding the fact that Ilyushin and Tupolev are staffed with excellent designers and engineers and have been designing and producing civil aircraft for their traditional markets for decades, myriad problems plague the industry. The primary obstacle is the lack of capital. Russian Government funding and private investment are very limited, and foreign government funding, while important, would not generally go beyond supporting foreign content on Russian LCA. Funding deficiencies prevent Russian LCA manufacturers from producing enough aircraft to generate the necessary income for design firms and production facilities to meet even their most basic needs.

Second, overcapacity in the Russian LCA industry and the inability of the industry to integrate design and production entities will continue to keep Ilyushin and Tupolev from achieving world-class producer status. While they represent the new generation of Russian airliners, the I1-96 and Tu-204 nonetheless are products of the old system where design bureaus worked in isolation from serial production facilities and without the benefit of market research.[395] The current corporate structures of Ilyushin and Tupolev do not allow streamlined decision making, prevent products from getting to market rapidly, and do not present a unified front for customer relations. Moreover, market research methods are new to the Russian industry, with design bureaus and production facilities showing little interest in learning such skills. In addition, no global network exists to support the Il-96 and Tu-204, a basic requirement of global LCA sales.

Lastly, Russian Government policies for the aviation and aerospace industries lack a coordinated approach toward promoting the interests of both the LCA manufacturers and the airlines. The government is not taking an active role in implementing the "Concept of Restructuring the Russian Aviation Industry Complex"; this plan has the potential to eliminate overcapacity and assist in the transition to more market-oriented corporate structures. The government has not developed a mechanism for leasing Russian aircraft, which would promote sales of these aircraft in the domestic market. This would be an important first step toward expanding sales to the global market. The government assesses tariffs on Western equipment for incorporation on Russian LCA, enforces a cumbersome certification process for such equipment, and applies standards in an inconsistent manner; however, Western equipment is essential to the competitiveness of Russian LCA, both domestically and globally. Finally, the government has taken limited steps to increase the accessibility of foreign-built LCA to Russian airlines; access to foreign-built aircraft would allow Russian airlines to move toward profitability through the lease and purchase of more affordable and efficient Western aircraft.

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[394] Russian industry expert and consultant, interview by USITC staff, Moscow, Mar. 27, 1998.

[395] Aviacor Joint Stock Company/Aviacor International official, interview by USITC staff, Samara, Russia, Apr. 2, 1998.

CHAPTER 5
CHANGES IN THE STRUCTURE OF THE ASIAN AEROSPACE INDUSTRY: CHINA, KOREA, INDONESIA, AND SINGAPORE

Overview

The absence of a comprehensive technological base for aircraft development and an overall lack of experience in all phases of an aircraft manufacturing program have thus far prevented the emergence of an Asian contender in the commercial aircraft industry. Further, it is unlikely that Asian nations will overcome these obstacles to compete with established producers of large civil aircraft (LCA) in the next 15-20 years.[396] Nonetheless, China, Korea, Indonesia, Singapore, and to a lesser extent Japan and Taiwan, seek an expanded presence in commercial aerospace and are actively pursuing international linkages to accelerate their nations' industrial and technological capabilities in aircraft manufacturing. Though the current economic crisis in the region may seriously affect one of Asia's strongest competitive assets--the ability and desire to contribute significant public resources to the development of commercial aircraft projects--the growth strategies of each country have effected the development of specific strengths conducive to aircraft production. Following a brief discussion of the evolution of the aircraft sector in each country, this chapter presents a competitive assessment of those strengths, as well as the inherent potential of each nation's aviation sector. Specifically, the competitive potential of the Asian aerospace industry will be evaluated based on the four distinct determinants of competitiveness discussed in Chapter 2: availability of capital, industrial and demographic characteristics, corporate characteristics, and program characteristics. The chapter then examines the implications of Asian nations' participation in the aircraft sector for the competitiveness of the U.S. industry.

China

Background

The Chinese aircraft industry dates to 1938 with the establishment of airframe and engine manufacturing facilities by the Japanese during their occupation of Manchuria.[397] At the end of World War II, the Soviet Union, in addition to maintaining these sites, sponsored the development of a number of additional factories, and the Chinese began licensed production of both military and civil aircraft from Soviet designs and technology.[398] After the breakup of Sino-Soviet relations in the early 1960s, China emerged isolated from both the Soviet Union and the West and

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[396] Transcript of hearing for USITC inv. No. 332-384, Mar. 17, 1998, p. 18.

[397] Leslie Symons, "The Rise and Fall of Soviet Influence on the Chinese Aircraft Industry and Air Transport," ch. 16 in *Transport and Economic Development--Soviet Union and Eastern Europe* (Berlin: Osteuropa-Institut, 1987), p. 450.

[398] Ibid.

was forced to sustain its aerospace needs and manufacturing base through reverse-engineered versions of Soviet aircraft and independent adaptation of Soviet-acquired technology.[399] Following a decrease in aviation activity during the Cultural Revolution, China achieved the first of many strategic links with Western manufacturers in a 1975 agreement with Rolls-Royce (United Kingdom) for the licensed production of engines.[400] Subsequent agreements for licensed production, coproduction, and joint-venture arrangements with The Boeing Co. (Boeing), McDonnell Douglas Corp. (McDonnell Douglas), and more recently, Airbus Industrie, G.I.E. (Airbus), have provided China with the desired experience and training necessary to advance the country's civil aircraft industry. In China's latest phase of development, the nation's aerospace industry has pursued international collaboration on the design, manufacture, and marketing of a 100-seat commercial aircraft. However, China has been unable to assume a principal role in an aircraft program as attempts at cooperation with Korea on a regional jet program broke down in 1996, followed by the dissolution in July 1998 of an agreement between China, Singapore, and Airbus Industrie Asia (AIA)[401] for the joint development and production of the AE-31X 100-seat passenger jet.[402]

Manufacturers and Major Products Produced

China's aerospace industry is managed under the state holding company, Aviation Industries of China (AVIC). AVIC, which estimates 1997 sales at $3.1 billion,[403] consists of 18 factories involved in the production of aircraft and components, 34 related equipment manufacturers, 29 aeronautical research institutes, 4 aeronautical universities, and 8 trading companies.[404] AVIC employs a total of 560,000 persons in its various companies and institutes. However, since AVIC's operations include non-aerospace-related activities[405] and the production of commercial products other than aircraft and components, the proportion of employees directly involved with aviation-related products is only 20 percent.[406] Traditionally a manufacturer of military aircraft and parts for the domestic market, AVIC has guided the industry toward civil aviation in response to a decline in military orders and as a strategic move to advance China's capabilities in the commercial aircraft sector.[407] AVIC's major manufacturing facilities involved in production and assembly for the civil aircraft sector include Xi'an, Harbin, Shanghai, Chengdu, and Shenyang (table 5-1). A second government organization under the direction of AVIC, the China Naitonal

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[399] Ibid., p. 463.

[400] Ibid., p. 451.

[401] See Chapter 3 for a discussion of AIA.

[402] Original plans called for the aircraft to be produced primarily by Xi'an Aircraft Company in two versions, the AE-316 for 95-105 passengers and the stretched AE-317, with accommodation for 115 in mixed-class configuration or 125 in a single-class layout. China's AVIC held a 46-percent stake in the partnership; AIA and Singapore Technologies Aerospace held shares of 39 percent and 15 percent, respectively.

[403] "Aircraft Maker AVIC to Restructure," Knight-Ridder/Tribune Business News, found at Internet address http://www.newsedge, posted Sept. 30, 1997, retrieved Oct. 6, 1997.

[404] Aviation Industries of China, *Survey of Chinese Aviation Industry 1997/1998* (Beijing: Aviation Industry Press, 1997).

[405] For example, AVIC's aerospace work force includes those employed in hospitals, schools, and research institutes serving the various manufacturing complexes.

[406] Aviation Industries of China officials, interview by USITC staff, Beijing, China, May 5, 1998.

[407] Ibid.; "Aircraft Maker AVIC to Restructure;" Paul Jackson, ed., *Jane's All the World's Aircraft 1996-97* (Surrey, UK: Jane's Information Group Limited, 1997), p. 55; and "Aviation Industries of China to Enhance Competitiveness," *Beijing China Daily*, Sept. 27, 1997.

Table 5-1
China: Principal aerospace manufacturers

Company	Founded	Facilities	Staff	Nonaerospace product areas	Major aviation-related projects
Xi'an Aircraft Company	1958	Xi'an	20,000 -- total 4,400 -- engineers	Volvo buses (joint venture) Aluminum structures Antenna disks Ferris wheels (Accounting for 70 percent of total production)	Production of the Y-7 Components/parts production Production of military aircraft
Harbin Aircraft Manufacturing Corporation	1952	Harbin	17,000 -- total 2,269 -- engineers	Electromechanical products	Production of the Y-12 Components/parts production Partner in EC-120 helicopter program Production of Z-9 helicopter
Shanghai Aircraft Manufacturing Factory	1951	Shanghai	5,000 -- total	Automotive products Commercial machinery Hovercraft Aluminum wall panels	MD-90 Trunkliner – final assembly Components/parts production
Chengdu Aircraft Industrial Corporation	1958	Chengdu	19,000 -- total	Electromechanical machinery (Accounting for 10 percent of total production)	Components/parts production Production of military aircraft
Shenyang Aircraft Corporation	1951	Shenyang	20,000 -- total 7,000 -- engineers and technical management personnel	Automotive products Medium/large machinery Metal structural products Electromechanical products Storage equipment (Accounting for 50 percent of total production)	Components/parts production Production of military aircraft

Source: Compiled from various sources by USITC staff.

Aero-Technology Import and Export Corporation (CATIC), oversees foreign subcontract work and joint ventures, as well as trade in aerospace products.[408]

China currently manufactures a number of short- to medium-range turboprops for passenger use (table 5-2). These models are adaptations of Soviet-era designs, with the exception of the Y-12, a light-duty twin turboprop, designed and developed in China in the 1980s[409] and manufactured in variations for passenger, cargo, and survey use.[410] China is also involved in the production of parts and subassemblies (table 5-3), as well as several models of military aircraft and helicopters.

In 1994, China's aerospace sector and McDonnell Douglas finalized a $1.6 billion agreement for the coproduction of the MD-90 model LCA. Under the so-called Trunkliner program, a total of 40 MD-90-30s were to be produced for the Chinese market, half in the United States and half in China. In August 1998, China terminated the program due to an apparent lack of demand.[411] However, the nation's aircraft sector reportedly intends to continue the assembly of three aircraft with components already delivered to Shanghai Aircraft Manufacturing Factory.[412]

Goals of China's Aerospace Industry

Chinese industry officials agree that Chinese firms cannot expect to compete with Airbus or Boeing in the LCA industry.[413] Nonetheless, the nation's aviation sector intends to pursue a principal role in commercial aircraft manufacturing. The Chinese aviation community views the production of aircraft as a symbol of development, and industry leaders see a national aircraft program as a means to reduce the nation's dependence on costly imported aircraft.[414] Chinese sources stress that the industry's focus is on the shorter-range aircraft group, which is suited to the aerospace sector's existing capabilities and experiences and characterized by less competition from established producers.[415] Moreover, the industry's goal is to build an original aircraft of 100 seats through cooperative arrangements including Western participation.[416]

In addition to production of a 100-seat regional jet, the industry hopes to strengthen its role as a supplier with the addition of resources for manufacturing and development and increased subcontract work from Western aircraft producers.[417] China's aerospace sector would also like to expand its customer base with subcontract work from other Asian nations involved in aerospace

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[408] Jackson, ed., *Jane's 1996-97*, p. 54.

[409] *Jane's All the World's Aircraft 1983-84* (London, England: Jane's Publishing Company Limited, 1983), p. 33.

[410] Aviation Industries of China officials, interview by USITC staff, Beijing, China, May 5, 1998; and "China Wins Exports for Yun-12 Planes," Xinhua News Service, received by Newsedge/Lan, Mar. 18, 1996.

[411] Paul Lewis, "TrunkLiner Programme is Scrapped," *Flight International*, July 29-Aug. 4, 1998, p. 4.

[412] Ibid.

[413] China National Aero-Technology International Supply Corporation and Aviation Industries of China officials, interviews by USITC staff, Beijing, China, May 4-5, 1998.

[414] Aviation Industries of China officials, interview by USITC staff, Beijing, China, May 5, 1998.

[415] Ibid.

[416] Ibid.

[417] China National Aero-Technology International Supply Corporation, Xi'an Aircraft Company, and Shanghai Aircraft Manufacturing Factory officials, interviews by USITC staff, Beijing, Xi'an, and Shanghai, May 4-8, 1998.

Table 5-2
China: Passenger aircraft production

Aircraft	Origin	Seats	Range[1]	Engine	Certification	Units sold
MD-90-30T Trunkliner	McDonnell Douglas MD-90	153	2,085 (Max. payload with international reserves)	International Aero Engines -- IAE V2525-D5	None	None
Y-7 100 Y-7 200A Y-7 200B	Antonov Design Bureau[2] Based on An-24	52 (Y-7 100/200B) 56 (Y-7 200A)	491 (Y-7 100) 863 (Y-7 200A) (Max. payload) 1,070 (Y-7 100) 1,430 (Y-7 200A) (Max. fuel)	Chinese -- DEMC (Dongan) WJ5A 1 (Y-7 100) Pratt & Whitney Canada PW 127C (Y-7 200A) Chinese -- Dongan WJ5A 1G (Y-7 200B)	1986 CAAC certification (Y-7 100) 1998 CAAC certification (Y-7 200A)	120[3]
Y-12 II Y-12 IV	Harbin Aircraft Manufacturing Corporation New design	17 (Y-12 II) 18-19 (Y-12 IV)	723 (Y-12 II) (Max. fuel with 45 min. reserves) 707 (Y-12 IV) (Max. fuel with 45 min. reserves)	Pratt & Whitney Canada PT6A-27	1985 CAAC certification (Y-12 II) 1994 CAAC certification (Y-12 IV) 1995 FAA FAR Part 23 Rules (Y-12 IV)	98[4] (Y-12 II)
Y-5B(D)[5] Y-5B(K)	Antonov Design Bureau Based on An-2	12	456 (With 177 gallons of fuel)	Polish -- PLL Kalisz ASz-62IR-16 Chinese --SAEC (Zhuzhou) HS5	CCAR Part 23 Rules (China)	780[5]
Y-8B[7] Y-8C Y-8D	Antonov Design Bureau Based on An-12B	96	687 (Y-8B, Y-8D) (Max. payload) 1,858 (Y-8C) 3,032 (Y-8B, Y-8D) (Max. fuel)	Chinese --SAEC (Zhuzhou) WJ6	1993 CAAC certification (Y-8B, Y-8C)	60[8]

[1] Expressed in nautical miles.
[2] The Antonov Design Bureau is located in the Ukraine.
[3] Y-7s and Y-100s as of early 1997.
[4] As of Dec. 1997.
[5] The Y-5 series is manufactured by Shijiazhuang Aircraft Manufacturing Corporation (SAMC).
[6] Nanchang produced 727 Antonov An-2s under license between 1957-67, whereupon production was moved to SAMC, which subsequently produced an additional 53 aircraft through early 1997.
[7] The Y-8 series is manufactured by Shaanxi Aircraft Company.
[8] As of Dec. 1996. Includes all versions of the Y-8 series including those aircraft for military, survey, and cargo use.

Source: Compiled from various sources by USITC staff.

Table 5-3
China: Aircraft structures production

Company	Product	Application
Xi'an	• Vertical fin, forward access doors • Horizontal stabilizer • Vertical fin • Trailing edge ribs • Wing box, forward and mid fuselage • Wheelwell bulkhead • Access door • Fin (CFRP) • Header tanks, water float pylons, ailerons, doors • Panel assemblies • Doors, outer wing casings • Rear fuselage barrels	• 737 • 737-300 • 737-600/700/800 • 747 • MD-90 Trunkliner • MD-90 • A300/A310 • A320 • CL-415 • Beech 1900D • ATR 42 • ATR 72
Shenyang	• Rear fuselage - section 48 • Cargo doors • Empennage, electrical wiring subcontracts • Wing ribs, emergency exit hatch, machined parts • Baggage, service, and emergency exit doors • Tailcone, landing gear door, pylon components	• 737-600/700/800 • 757 • MD-90 Trunkliner • A320 • deHavilland Dash 8 • Lockheed C-130
Shanghai Aircraft	• Horizontal stabilizer • Horizontal stabilizer, aft service door jamb, inboard flap support, aft service door, main landing gear door, nose landing gear door, avionics access door, forward/mid/aft cargo door • Wing, center fuselage	• 737-600/700/800 • MD-80/90 • MD-90 Trunkliner
Chengdu	• Empennage, section 48 • Nose section • Nose section • Nose assembly, airstair assembly • Rear passenger door	• 757 • 717-200[1] • MD-80/90 • MD-90 Trunkliner • A320
Harbin	• Doors • Doors • Fuselage	• AVRO RJ aircraft • Dauphin series (Eurocopter) • EC-120 (Eurocopter)

[1] Under contract from Korean Air.

Source: Compiled from various sources by USITC staff.

manufacturing such as Japan and Korea.[418] Though manufacturers indicate a willingness to take on a variety of tasks from assembly work to component and subassembly manufacture, aviation industry leaders want China to secure more work in the fabrication of complex assemblies such as body sections and nose subassemblies.[419]

Competitive Assessment

Availability of Capital

The Chinese aviation sector benefits from a traditional base of public support for large industrial sectors such as aircraft manufacturing. Though the degree to which state funds are directed to the civil aircraft sector is difficult to quantify because of a lack of data and the diversity of AVIC's operations, China's aircraft industry presumably receives direct government support as a state-controlled enterprise. In addition, China's Export-Import Bank provides loans to support the export of civilian aircraft,[420] and certain aviation projects have reportedly been granted preferential tax status.[421] Moreover, the civil aircraft sector may receive added indirect financial benefits from government defense procurement. Though government orders for military aircraft have declined,[422] the industry's historical focus on military production and the current dual civil/military role of several of China's aerospace factories have likely provided the industry with infrastructure, experience in the manufacture and assembly of aircraft and parts, and funds for aeronautical research and development (R&D) for military use through which the industry can gain transferable technologies.

Historically, investment in the nation's aerospace companies came only from government sources.[423] However, as a result of government reforms aimed at transforming China's centrally planned economy to a more market-oriented system,[424] the use of financial markets to raise capital is expected to increase as enterprises are granted greater autonomy to list shares on the domestic stock exchange. Commercial fund-raising will provide Chinese aircraft companies with an alternate source of capital--particularly important as government support is likely to decline with the restructuring[425]--and could expose China's large industrial enterprises to competitive market forces and shareholder concerns such as profitability. AVIC reportedly will assist its civilian

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[418] Xi'an Aircraft Company officials, interview by USITC staff, Xi'an, May 7, 1998.

[419] China National Aero-Technology International Supply Corporation officials, interview by USITC staff, Beijing, China, May 4, 1998.

[420] "China: Bank Loan to Back Aviation Industry," *Beijing China Daily* (in English), Apr. 3, 1998, FBIS transcribed text FBIS-CHI-98-093.

[421] Paul Lewis, "Time Out in Asia," *Flight International*, Nov. 5-11, 1997, p. 40.

[422] Aviation Industries of China and Xi'an Aircraft Company officials, interviews by USITC staff, Beijing and Xi'an, China, May 5 and 7, 1998.

[423] Chinese industry officials, interview by USITC staff, Xi'an, May 7, 1998.

[424] In September 1997, the 15th Congress of the Chinese Communist Party endorsed a reform policy to overhaul state-owned enterprises through restructuring, elimination, and in certain cases, privatization. Certain government ministries may also be consolidated or eliminated.

[425] U.S. industry officials, interview by USITC staff, Beijing, China, May 4, 1998; and Michael Mecham, "Industry Watches Reform of Chinese Aerospace," *Aviation Week & Space Technology*, Mar. 2, 1998, p. 24.

subsidiaries with commercial fund-raising as the industry is reorganized,[426] and initial attempts of the aircraft industry to raise capital through the domestic stock market have reportedly met with success. In 1997, Xi'an Aircraft Company raised 357 million yuan ($44 million) from an initial public offering of 60 million shares to mainland Chinese investors,[427] and the company reports that its stock has performed well on the local market.[428] At the same time, China's stock exchange is subject to considerable speculation and strict government control,[429] which could limit sufficient capital mobilization. However, as China recently announced that it will allow a greater number of enterprises to list shares overseas,[430] it is conceivable that China's aircraft producers may ultimately be granted access to the greater fund-raising potential of foreign stock markets.

Industrial and Demographic Characteristics

Design and production capabilities

One of China's greatest competitive weaknesses is an aerospace industry that is nearly 30 years behind the United States and Western Europe in terms of design, development, and production skills.[431] Though China is one of the region's more active subcontractors, aircraft companies have primarily been assigned the fabrication of relatively low-technology parts and components. The nation's indigenous design capabilities are limited to skills in basic design,[432] modification, imitation, and adaption of existing designs; and Chinese industry sources acknowledge that while a foundation for a civil aircraft industry is in place, overall capabilities are comparatively low.[433] One problem is China's lack of sophisticated manufacturing technology.[434] For example, the industry is known to employ labor-intensive, time-consuming procedures rather than more sophisticated techniques due to unfamiliarity and inexperience.[435] More importantly, a history of manufacturing guided by a centrally planned system of production and a lack of experience in program organization, process management, and decision making at the factory level, have reduced the industry's ability to utilize skilled engineers and handle diversified production,

[426] "Aviation Industries of China to Enhance Competitiveness," *Beijing China Daily*, Sept.1997.

[427] "China Xi'an Plane Part Maker to List A Shr (sic)," Reuters Limited, June 24, 1997, found at Internet address http://biz.yahoo.com/finance/97/06/24/, retrieved June 25, 1997.

[428] Xi'an Aircraft Company officials, interview by USITC staff, Xi'an, May 7, 1998.

[429] U.S. Department of Commerce, International Trade Administration, "China--Investment Banking," *Market Research Reports*, National Trade Data Bank, found at Internet address http://www.stat-usa.gov, Aug. 1, 1997, retrieved July 28, 1998; and Morag Forrester, "China is the Silver Lining," *Global Finance*, Aug. 1997, pp. 32-34.

[430] "China to List More Firms Abroad," China Business News, Xindeco Business Information Company, July 21, 1998, found at Internet address http://www.chinavista.com/business/new/home.html, retrieved July 21, 1998.

[431] U.S. government and U.S. and European industry officials, interviews by USITC staff, Herndon, VA, Oct. 23, 1997, and Beijing, China, May 4, 1998; and Stanley Holmes, "Make a Faulty Part and You Will be Punished," *Seattle Times*, May 26, 1996, found at Internet address http://www.seattletimes.com/sbin/iarecord.../34043, retrieved Aug. 27, 1997.

[432] Korean industry official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[433] Chinese industry officials, interview by USITC staff, Beijing, China, May 5, 1998.

[434] Chinese and Korean industry officials, interviews by USITC staff, Beijing and Shanghai, China, May 5 and 8, 1998 and Pusan, Korea, Apr. 29, 1998.

[435] China's inexperience is evident in the riveting process. Instead of precisely driving rivets into metal components at a specified level, Chinese technicians leave the rivets slightly extended and later grind them down to the proper level. While the Chinese method is more inefficient, factories avoid having to discard parts, which is necessary if a rivet is inserted too deeply.

multiple tasks, and the complex integration of an aircraft program.[436] For example, the disparate levels of skill in China's factories, combined with difficulties in managing production processes and integration, have contributed to delays in the completion date for the first Chinese-made MD-90 Trunkliner.[437]

Despite these shortcomings, Chinese producers are capable of supplying quality products that conform to strict Western standards. Moreover, the industry has an advantage over other Asian aspirants in its many years of experience in building complete aircraft.[438] For example, in addition to the production of military fighters and short-range turboprops, the industry successfully assembled and later coproduced[439] 35 MD-82 172-seat commercial jetliners under a 1985 agreement with McDonnell Douglas, 5 of which were sold in the U.S. market. In addition, China's more experienced and modernized suppliers understand quality assurance.[440] Although industry sources stress that time and close cooperation are necessary to ensure Chinese reliability on new programs, once a foundation is in place and workers are trained to the standards and production practices of Western producers, China's aircraft factories are able to produce high-quality parts, components, and subassemblies.[441] For example, while Boeing always begins with dual sources of supply when placing work in China,[442] Chinese factories have achieved the status of sole supplier on certain Boeing parts and complex assemblies,[443] an indication of Western LCA manufacturers' growing level of confidence in China's subcontracting abilities. Further, Chinese factories indicate an awareness of their weaknesses in quality assurance and are attempting to improve product quality through manufacturing experience with Western producers and by emulating the practices of successful Chinese suppliers.[444]

Manufacturing infrastructure

A factor inhibiting China's growth as an aerospace manufacturer is the lack of modern production facilities. The Chinese industry's manufacturing infrastructure is roughly parallel to that of U.S. airframers' facilities in the 1950s,[445] characterized by basic machinery and a lack of computerization. Strict export license requirements of supplier countries make it difficult for firms to obtain the latest and most technologically advanced machinery[446] and though the industry supports a degree of self-sufficiency in machinery production, indigenously designed and fabricated tools provide factories with unique engineering solutions to Western fabrication

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[436] Chinese and U.S. industry officials, interviews by USITC staff, Beijing, May 4, 1998.

[437] Although the Trunkliner Program was canceled, China is expected to produce a total of three aircraft from parts and components already delivered to or produced in China. The first MD-90-30 produced in China under the Trunkliner Program was originally scheduled for delivery in April 1998. The industry was unable to meet this goal, and delivery was rescheduled for late 1998; however, Chinese industry sources indicate that another delay is probable. Chinese industry officials, interview by USITC staff, Shanghai, China, May 8, 1998.

[438] U.S. and Korean industry officials, interviews by USITC staff, Beijing, China and Changwon, Korea, Apr. 30 and May 5, 1998.

[439] Chinese content accounted for 20 percent of the aircraft.

[440] U.S. Government official, interview by USITC staff, Beijing, China, May 4, 1998.

[441] U.S. industry officials, interview by USITC staff, Xi'an, China, May 7, 1998.

[442] U.S. industry officials, interview by USITC staff, Seattle, WA, Feb. 10, 1998.

[443] For example, Xi'an is currently sole supply on the 737 forward access door and 747 trailing edge ribs. Chengdu became sole supplier for the MD-82 nose structure.

[444] Chinese industry officials, interview by USITC staff, Shanghai, China, May 8, 1998.

[445] U.S. industry officials, interview by USITC staff, China, May 7, 1998.

[446] Chinese industry officials, interviews by USITC staff, Beijing and Shanghai, China, May 4 and 8, 1998.

demands. In addition, while a domestic supplier base for raw materials exists, the aircraft industry, particularly the parts manufacturing sector, depends primarily on imports of aircraft quality aluminum, titanium, and other raw materials from Western nations due to strict customer demands regarding quality and approved suppliers.[447] This increases costs, inconvenience, and risk, and Chinese industry sources cite difficulty in obtaining increasingly important advanced aircraft materials such as composites and carbon fiber due to the strict export license requirements of certain supplier countries.[448]

Further, China lacks a key element for the development of an indigenous LCA industry--sufficient aeronautical R&D facilities for the production of independent aircraft designs. For example, while each of China's aircraft manufacturers supports its own independent design institute, activities are limited to less sophisticated tasks such as design modification.[449] Moreover, only two of AVIC's 29 aeronautical research facilities are chiefly involved in design research for commercial aircraft--Xi'an Aircraft Design and Research Institute and Shanghai Aircraft Research Institute (SARI).[450] These facilities have yet to produce original designs for LCA.[451] Designs produced by Xi'an Aircraft Design and Research Institute have primarily been adaptations or copies of existing aircraft models.[452] Similarly, SARI's largest design project, the Y-10, a 150-seat passenger aircraft developed in the 1970s, borrowed heavily from existing Western technology.

Benefitting the nation's aircraft industry are China's vast land area, the nation's policy of developing inland provinces, and the country's rapid construction of air transportation infrastructure, which offer significant potential for the expansion of aircraft manufacturing facilities, air fields, and test sites. An additional advantage China enjoys over other aspiring airframe competitors is a large pool of experienced aerospace workers[453] with wages an estimated 30 to 50 percent below those in Western Europe.[454] Production workers average 10 years of experience in the industry and the Chinese aerospace sector boasts a number of high-level technicians.[455] At the same time, while China's academic system reportedly produces talented engineers,[456] only four Chinese universities support programs that specialize in aeronautics and aviation.[457] By comparison, approximately 80 universities in the United States offer degrees in

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[447] Chinese industry officials, interview by USITC staff, Beijing, May 5, 1998.

[448] Chinese industry officials, interviews by USITC staff, Beijing and Shanghai, China, May 4 and 8, 1998.

[449] Aviation Industries of China officials, interview by USITC staff, Beijing, China, May 5, 1998.

[450] Ibid.

[451] European industry officials, interview by USITC staff, Paris, France, Apr. 3, 1998.

[452] Aviation Industries of China, *Survey of Chinese Aviation Industry 1997/1998* (China: Aviation Industry Press, 1997), p. 149.

[453] Aviation Industries of China officials, interview by USITC staff, Beijing, China, May 5, 1998.

[454] Lewis, "Time Out in Asia," p. 39.

[455] Aviation Industries of China and Shanghai Aircraft Manufacturing Factory officials, interviews by USITC staff, Beijing and Shanghai, China, May 5 and 8, 1998.

[456] U.S. industry officials, interviews by USITC staff, Beijing, China, May 5, 1998.

[457] The four universities are Beijing University of Aeronautics and Astronautics, Northwestern Polytechnical University (Xi'an), Nanjing University of Aeronautics and Astronautics, and Zengzhou Institute of Aeronautics.

aerospace engineering.[458] Further, Chinese industry sources report difficulty in retaining both engineers and higher level technical workers who often leave the industry for higher paying jobs.[459]

Domestic market conditions

China's foremost competitive advantage is a huge domestic market, a critical element in the success of an aircraft program.[460] Chinese officials estimate domestic demand for 100-seat aircraft at 265 units during 1997-2016,[461] with Western forecasts for the same period slightly higher. In addition, some Chinese airlines indicate a need for a medium-sized passenger aircraft for increased frequencies and access to remote regional cities.[462] Potential domestic demand, combined with lingering government influence in airlines' purchases,[463] creates a near-captive market for any Chinese aircraft built independently or in cooperation with foreign partners. One industry representative, for example, predicts that a Chinese-made regional jet could capture nearly 100 percent of the domestic market in the aircraft's first years of production.[464]

Corporate Characteristics

A prime weakness of the aviation sector is the industry's inefficient, vertical system of administration, which has inhibited the modernization of China's aircraft factories.[465] However, government reforms intended to decrease overlap, raise efficiency, and guide state-owned enterprises toward market-oriented practices could have a beneficial effect on the overall strength and competitiveness of China's aircraft industry. Essentially, China's aviation industry will be granted operational autonomy,[466] and decision making will be shifted to the factory level in order to make China's factories function in a more businesslike fashion.[467] Localized control could improve competitiveness and productivity in the manufacturing sector by allowing factories access to new sources of capital and greater command over efficiency-raising measures such as downsizing and the abandonment of uneconomical programs. Further, under the government's restructuring program, AVIC may be reassembled into several groups under which the nation's aircraft factories and research institutes will operate, and aircraft production is likely to be fully separated from the manufacture of other civilian products.[468] This may lead to consolidation in the industry as aircraft factories lose financial support from other money-making commercial operations.

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[458] Peterson's Colleges & Universities, found at Internet address http://www.petersons.com/ugrad/select/u40050se.html, retrieved September 9, 1998.

[459] China National Aero-technology International Supply Corporation and Aviation Industries of China officials, interviews by USITC staff, Beijing, China, May 4-5, 1998.

[460] Large domestic sales assist the manufacturer in achieving economies of scale. U.S. aerospace industry analyst and Korean Government officials, interviews by USITC staff, Washington, DC, Dec. 9, 1997, and Seoul, Korea, May 1, 1998.

[461] China Institute of Aeronautic Engineering, *China Market Outlook for Civil Aircraft (1997-2016)*, Sept. 1997, p. 23.

[462] Chinese airline officials, interview by USITC staff, Beijing, May 5, 1998.

[463] Chinese Government official, interview by USITC staff, Beijing, China, May 4, 1998.

[464] U.S. industry official, interview by USITC staff, Beijing, China, May 5, 1998.

[465] Mecham, "Industry Watches Reform," p. 24; and Asian aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[466] Chinese and U.S. industry officials, interviews by USITC staff, Beijing, China, May 4-5, 1998.

[467] Mecham, "Industry Watches Reform," p. 24.

[468] Chinese industry officials, interview by USITC staff, Beijing, China, May 5, 1998.

At the same time, the extent to which China's aerospace industry can take advantage of structural reorganization depends on the pace and nature of change, and full implementation of aviation sector reforms is expected to be slow.[469] For example, in 1997, AVIC announced plans to cut its total work force by approximately 150,000, or 27 percent, in an attempt to streamline operations and boost efficiency and productivity.[470] To date, Chinese employment in the aerospace sector remains unchanged and it is unclear what steps have been taken to achieve this goal. Nonetheless, certain Chinese aviation companies have already adopted some market-oriented practices. For example, China's major aircraft factories have operated for nearly a decade on a self-pay, self-revenue system,[471] and select companies are open to public investment.

Program Characteristics

China lags its Western and Asian counterparts in marketing skills, an understanding of after-sales support, and the resources for development and maintenance of a global support network.[472] China's aircraft sector is weak in independent product research, promotion, and marketing, with AVIC-run trading companies relying largely on developing country markets for overseas sales of aircraft. In addition, for any regional jet China might produce, foreign assistance will be necessary for flight personnel training, parts supply, and engineering and maintenance support.[473]

China could also face difficulty selling aircraft at a competitive price on the world market. Although the industry is cost competitive in first- and second-tier parts supply,[474] the amount of training, number of production hours, and degree of oversight required to support the industry through a comprehensive aircraft program translates into a higher cost for Chinese-built aircraft. For example, despite plans for nearly 80 percent of production to take place in China,[475] issues concerning cost and profitability plagued the AE-31X program.[476] Likewise, industry sources report that each of the 20 aircraft scheduled to be built and assembled in China under the Trunkliner program were expected to cost approximately $10 million more than the corresponding aircraft built at Boeing's Long Beach, CA, facility.[477]

Though China's industry has limited experience in building aircraft to Western standards, cooperation with Western airframers and the U.S. Federal Aviation Administration (FAA) has improved China's recognition and acceptance of world standards of quality. China has a Bilateral Airworthiness Agreement (BAA) with the United States, and the Civil Aviation Administration

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[469] Mecham, "Industry Watches Reform," p. 24.

[470] "News Briefs," *Air Transport World,* Nov. 1, 1997, p. 23.

[471] In other words, China's factories are responsible for paying employees' salaries from revenues earned through the sale of aviation and commercial products. Xi'an Aircraft Company and Shanghai Aircraft Manufacturing Factory officials, interviews by USITC staff, Xi'an and Shanghai, China, May 7-8, 1998.

[472] Chinese industry officials, interview by USITC staff, Shanghai, China, May 8, 1998.

[473] U.S. industry official, interview by USITC staff, Beijing, China, May 5, 1998.

[474] Tier-one suppliers act as prime suppliers to an industry. In the aircraft industry, some first-tier suppliers possess design and systems integration skills, as well as the ability to assemble complex parts and assemblies. A second-tier supplier may act as an alternate to a first-tier, but is less likely to posses design and/or systems integration capabilities. Second-tier suppliers may also provide components to first-tier suppliers.

[475] Lewis, "Time Out in Asia," p. 39; and "Airbus Considers Producing All AE31X Airframe in China," *Flight International,* Oct. 8-14, 1997, p. 5.

[476] Max Kingsley-Jones, "Airbus Examines A319 Shrink," *Flight International,* Mar. 4- 10, 1998.

[477] U.S. industry official, interview by USITC staff, Beijing, China, May 4, 1998.

of China (CAAC), China's governing body responsible for national certification processes has, in principle, adopted the safety standards and requirements of the FAA.[478] Inconsistent application of safety standards still exists across the manufacturing sector and central planning remains an impediment to effective regulatory oversight.[479] However, U.S. aviation officials indicate a growing confidence in China's standards and practices, manifest in the FAA's shadow certification of the Y-12 IV in 1995.[480] Certification helped China penetrate the North American market with an agreement in 1998 with the Canadian Aerospace Group for up to 200 "green" Y-12 IV aircraft over 10 years.[481] While concerns remain over the quality of some Chinese-made parts, four of the nation's factories have been approved by Boeing,[482] two by Airbus,[483] and U.S. safety officials have indicated a willingness to rely increasingly on CAAC oversight versus direct ongoing FAA supervision.[484] Further, CAAC intends to shed a number of the agency's peripheral responsibilities in order to assume a greater role in safety and regulatory control.[485]

Arrangements with Foreign Aerospace Entities

China's aircraft industry recognizes that international collaboration is necessary to augment competitive factors that are weak or absent in the Chinese aircraft sector. The nation's aviation leaders clearly expect suppliers of LCA to China to participate in building the local industry and utilize offset agreements[486] and cooperative projects to bring aviation-related work and transferable skills and technology to the nation's aircraft factories.[487] China's low-cost manufacturing base and large potential market for commercial aircraft are incentives for foreign aerospace firms to enter such agreements, and sources note that China is adept at using these assets to achieve the maximum possible gain through international collaboration.[488] To date, the aircraft sector has attracted coproduction, codevelopment, and subcontract agreements with Western airframers, European regional jet and helicopter producers, as well as other Asian producers.

Boeing has made significant contributions to the modernization and technical advancement of China's manufacturing facilities through a number of cooperative ventures. The company has sourced various parts and assemblies for its family of aircraft over the past two decades, gradually expanding the number of subcontracts and technical level of work packages placed in Chinese factories. Through such arrangements, Boeing has supplied China with basic aerospace technologies and has helped Chinese firms improve program management skills and the quality of their product through investment in Chinese factories and training initiatives, including Seattle-based instruction in computer-aided design and product integration.[489] Partly as a result of Boeing's long-term involvement in the Chinese manufacturing sector, 80 percent of all Chinese-

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[478] U.S. Government official, interview by USITC staff, Beijing, China, May 4, 1998.

[479] Ibid.

[480] Ibid.

[481] A "green" aircraft is an unpainted aircraft that has not been fitted with the interior components. Aviation Industries of China officials, interview by USITC staff, Beijing, China, May 5, 1998.

[482] U.S. and Chinese industry officials, interviews by USITC staff, Seattle, WA, Feb. 10, and Beijing, China, May 4, 1998.

[483] Chinese industry officials, interview by USITC staff, Beijing, China, May 4, 1998.

[484] U.S. Government official, interview by USITC staff, Beijing, China, May 4, 1998.

[485] Chinese Government official, interview by USITC staff, Beijing, China, May 4, 1998.

[486] See Appendix G for a further discussion on offsets.

[487] U.S. Government and Chinese industry officials, interviews by USITC staff, Beijing, China, May 4-5, 1998.

[488] U.S. Government officials, interview by USITC staff, Beijing, China, May 4, 1998.

[489] Holmes, "Make a Faulty Part."

built aircraft components go to Boeing, and Boeing has approximately 70 percent of the Chinese LCA market.[490]

The former McDonnell Douglas provided the Chinese with experience in the manufacture of LCA with the 1985 licensed production and assembly agreement for the MD-82, one of four versions of the MD-80. The program to initially assemble and later coproduce the MD-82 was the first Sino-Western aircraft production agreement, and it provided the Chinese with process technology transfer, training, and equipment. Moreover, initial cooperation with McDonnell Douglas on the MD-90 Trunkliner program, China's largest aircraft coproduction agreement,[491] provided Chinese factories with tooling for detailed parts and technical instruction for aircraft production and assembly.[492]

While the aforementioned arrangements have provided China with basic inputs and experience, the Chinese aircraft industry has been unsuccessful in gaining greater core technology transfer in design, process management capabilities, and integration skills through partnerships with foreign aerospace firms. China actively pursued advanced aircraft manufacturing technologies through cooperation with Airbus[493] on the AE-31X regional transport program. Through collaboration with Airbus, China hoped to obtain technology transfer to bring Chinese aircraft design, program management, testing, and certification abilities to a level of international competitiveness.[494] However, discussions on the price of technology transfer were the project's most contentious issue,[495] causing incessant delays in development. Sources indicate that Airbus, in its desire to penetrate the Chinese market, may have committed to a greater amount of technological assistance than it was ultimately willing to provide.[496] As a result, and because of expressed concerns over the viability and profitability of the AE-31X aircraft, the project was canceled in July 1998. Airbus is reportedly considering engaging China in a substitute collaborative program involving wing production;[497] the nature of this project and extent of Chinese participation could have an effect on the course of future collaborative arrangements between foreign aerospace firms and Chinese aircraft companies.

China's aviation industry officials stress that gaps in design, manufacturing, and marketing capabilities necessitate cooperation with established producers on a national aircraft project.[498] China also recognizes that market access is the prime incentive for Western partners to enter joint-

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[490] Chinese industry officials, interview by USITC staff, Beijing, China, May 5, 1998.

[491] Michael Mecham, "Trunkliner Work Begins in China," *Aviation Week & Space Technology,* Sept. 4, 1995, p. 27.

[492] U.S. Government and industry officials, interviews by USITC staff, Beijing and Xi'an, China, May 4 and 7, 1998.

[493] Airbus held a 62-percent stake in AIA, the Western partner in the AE-31X program. Partner Alenia/Finmeccanica accounted for the remaining 38 percent.

[494] Paul Lewis, "European/Chinese Regional-Aircraft Deal Hits Hurdles," *Flight International,* Oct. 23-29, 1996, p. 4; and Duncan Macrae, "Europe Celebrates Breakthrough on Chinese Market," *Interavia*, Nov. 1996, p. 28.

[495] Lewis, "Time Out in Asia," p. 39.

[496] Asian industry officials, interviews by USITC staff, Korea, China, Indonesia, and Singapore, Apr. 27-May 14, 1998.

[497] "Airbus Sees Growth, Cooperation in China," Reuters Limited, Nov. 15, 1998, found at Internet address http://biz.yahoo.com/rf/981115/cz.html, retrieved Nov. 16, 1998.

[498] Aviation Industries of China and Shanghai Aircraft Manufacturing Factory officials, interviews by USITC staff, Beijing and Shanghai, China, May 5 and 7, 1998.

development programs with Chinese aerospace entities.[499] In arrangements with Chinese manufacturers, established producers have demonstrated a willingness to supply China with some of the basic tools necessary for aircraft production. While established manufacturers point out that advanced technologies, such as modern designs for the cockpit and wing, have thus far been kept from potential competitors such as China,[500] future growth in the competitiveness of China's aircraft industry may increasingly depend on the trade-off between access to China's market and the transfer of advanced skills and technologies from established manufacturers.

Korea

Background

The Korean aircraft industry developed as a maintenance center during 1950-60. The industry later expanded its activities to include licensed production of airframes and became heavily involved in the defense sector, building helicopters and fighters for the Korean military. By the 1980s, Korea's aerospace sector built an industrial base capable of producing parts and components under license from foreign interests, and the government assumed an active role in the promotion of commercial aerospace. Presently, the industry is developing along the government's long-term growth plan for 1997-2005, which calls for the commercial aircraft industry to focus on the production of parts for LCA and the development of medium-sized commercial aircraft.[501] Korea's many attempts to achieve the latter have been unsuccessful, however, as Korean cooperation with Western entities has failed to produce concrete plans for aircraft production, and differences over final assembly and manufacturing rights led to a dissolution of the Korea-China agreement for development of a 100-seat regional jet. Nonetheless, both the Korean government and industry have repeatedly expressed the desire that Korea become a global competitor in the aerospace industry,[502] and the aerospace sector plans to continue its efforts to produce a passenger aircraft.

Manufacturers and Major Products Produced

The Korean aerospace industry is dominated by four major firms: Samsung Aerospace, Korean Air, Daewoo Heavy Industries, and Hyundai Space & Aircraft (table 5-4). These companies account for over 80 percent of total production,[503] most of which serves the military sector. Samsung also acts as lead partner in the Korea Commercial Aircraft Development Consortium

[499] Chinese industry officials, interview by USITC staff, Beijing, China, May 5, 1998.

[500] U.S. and European industry officials, interviews by USITC staff, Seattle, WA, Feb. 10, 1998, and Herndon, VA, Oct. 23, 1997; and Joint Economic Committee, Congress of the United States, ed., *China's Economic Future: Challenges to U.S. Policy* (New York: M.E. Sharpe, 1997), p. 302.

[501] USDOC, ITA, "Korea--Aircraft Parts," National Trade Data Bank, found at Internet address http://www.stat-usa.gov, Mar. 1, 1997, retrieved Oct. 28, 1997. The Korean aerospace industry characterizes a medium-sized commercial passenger jet as an aircraft with 70-100 seats.

[502] Charles Bickers, "Airborne Ambition," *Far Eastern Economic Review*, June 5, 1997, p. 63; and Paul Lewis, "Upwardly Mobile: Aerospace in South Korea Continues to Develop Apace," *Flight International*, Oct. 23-29, 1996, p. 31.

[503] USDOC, ITA, "Korea--Aircraft Parts."

Table 5-4
Korea: Principal aerospace manufacturers

Company	Founded	Facilities	Staff	Annual sales (millions)	Major projects
Samsung Aerospace Industries	1977	Changwon - 3 plants, training center Sachon - aircraft assembly Daeduk - Aerospace R&D center	3,248[1]	$1,024[2] (1997)	Prime contractor - Korean Fighter Program Prime contractor - KTX-2 advanced trainer
Korean Air Aerospace Division	1976	Pusan - maintenance, overhaul, manufacturing	2,300[3]	$170[4] (1997)	Design, manufacture, and testing of the Korean Chang-Gong 91 4- to 5-seat monoplane (first flight 1991)
Daewoo Heavy Industries Aerospace Division	1984	Changwon	1,307 -- total 601 -- engineers	$114[5] (1997)	Prime contractor - KTX-1 primary trainer Prime contractor - Korean Light Helicopter Program Korean Fighter Program
Hyundai Space & Aircraft Co., Ltd.	1994	Sosan	537 -- total[6] 202 -- production engineers 184 -- R&D	$10 (1996)	Boeing 717-200 wing production

[1] Total in aerospace. Total work force is estimated at 7,997 for 1998.
[2] Total sales generated by the Aerospace & Defense Group. Total sales of Samsung Aerospace, which includes the Aerospace & Defense Group and Industrial Products Group, were $1.9 billion in 1997. Approximate sales for the Aircraft Sector, a division of the Aerospace and Defense Group, are $250 million (1998).
[3] Total in aerospace. Total work force in maintenance and military and civil production is 20,000 (1997).
[4] Total generated by aerospace. Total revenues for all divisions amounted to $8.5 billion in 1997.
[5] Civil production accounted for 30 percent or just over $34 million.
[6] Hyundai Space & Aircraft estimates that total manpower will reach 652 persons by the end of 1998 primarily due to the addition of 117 production workers.

Source: Compiled from various sources by USITC staff.

(KCDC), a 14-member group formed by the government in 1994 to lead Korea's participation in a 100-seat civil aircraft program.[504]

The Korean aerospace industry supports a total of 11,958 workers, including 6,052 technicians, 1,393 persons in R&D, and 3,370 engineers,[505] involved in the production of parts and subassemblies for both military and commercial transport (table 5-5). Though the industry does not perform full-scale production of commercial aircraft, it has experience in the licensed manufacture of helicopters and military aircraft. Currently, the industry's most comprehensive

[504] Michael Mecham, "Samsung-Fokker Plan Meets with Skepticism," *Aviation Week & Space Technology*, Oct. 28, 1996, p. 26.
[505] Korea Aerospace Industries Association, *1997 Annual Report*, p. 10.

Table 5-5
Korea: Aircraft parts and components production

Company	Product	Application
Samsung	• Wing ribs[1] • Stringers, frames[2] • Crown frames, APU door, pressure bulkhead,[2] fixed T/E [2] • Stringer/crown frames • Wing ribs, fixed T/E[2] • Wing structures • Empennage • Stang beams[2] • Vertical fin, landing gear doors, remote interface units • Engine mounts, fuel system • Engine parts	• 737 • 747 • 757 • 757-300 • 767 • 767-400ER • Dash 8-100/200/300 • Gulfstream IV • F-16 • KTX-1 • J79, CF6, CT7 (General Electric); F100, JT8D, JT9D, PW4000 (Pratt & Whitney); CFM 56 (CFM)
Korean Air	• Nose section • Flap support fairings • Flap support fairings, wing tip extension • Flap support fairings, wing tip assembly • Upper part of center fuselage • Control surfaces	• 717-200 • 737-600/700/800 • 747 • 777 • A330/340 • F-16
Daewoo Heavy Industries	• Wing inspar ribs, stretched upper deck frame assembly[2] • Stringers[2] • Nacelle fittings • Upper shell section 15 • Fuselage shell • Stang beam[2] • Outer wing • Ventral fin, center fuselage, cockpit side panel	• 747 • 767 • 777 • A320 • Dornier 328 • Gulfstream IV • P-3C/B • F-16
Hyundai	• Wing • Pylons • Pylons	• 717 • F-16 • KTX-1
Hanwha Machinery	• Horizontal tail actuator, flaperon actuator, rudder actuator • Actuators, manifolds, valves	• F-16 • KTX-1

[1] Under contract from Kawasaki Heavy Industries.
[2] Under contract from Northrop-Grumman Corp.

Source: Compiled from various sources by USITC staff.

role in aerospace manufacturing is represented by the Korean Fighter Program, a $5.2 billion agreement with U.S.-based Lockheed Martin for the licensed production of F-16 fighters.[506] Under the program, the Korean industry is responsible for producing 70 percent of the airframe, up to 50 percent of the avionics, and 43 percent of the aircraft's Pratt & Whitney engines.[507] Two additional military programs are currently under development, the KTX-1 primary trainer project and the KTX-2 advanced trainer joint development program,[508] both of which rely chiefly on Korean design and production resources.

Goals of Korea's Aerospace Industry

Despite the country's recent financial difficulties, the Korean industry retains the long-held goal of becoming one of the world's top 10 aerospace manufacturers by 2010.[509] Korean firms aim to sustain a high level of sales as major first- and second-tier suppliers to Boeing, Airbus, and other Western producers,[510] increase production of structures and fuselage sections,[511] and in the process accumulate advanced aviation technologies.[512] Korean industry sources further assert that Korean manufacturers are interested in subsystem development projects such as medium-sized aircraft engines, landing gear systems, and transmissions.[513] Finally, both the Korean Government and the nation's aerospace companies want the industry to participate in the development of a commercial aircraft.

A primary objective behind Korea's intent to assume a principal role in the design and production areas of a civil aircraft program is the nation's interest in establishing a greater presence in high technology sectors.[514] Further, Korea hopes to bolster the economy through involvement in sophisticated industries[515] and gain production work to occupy downtime between military programs.[516] A more prominent though unconventional aim is Korea's desire to use the design technologies, understanding of airframe construction, and integration and manufacturing skills gained through the production of a complete aircraft to enhance the industry's status as a

[506] Michael Mecham, "South Korean Manufacturers Make F-16 Their Star," *Aviation Week & Space Technology*, Oct. 14, 1996, p. 49. Following the shipment of 12 aircraft to Korea from Lockheed Martin's Fort Worth, TX, facility, Samsung and 9 other Korean manufacturers assumed a subcontracting role with the assembly of 36 fighters from imported kits. An additional 72 F-16s are to be constructed in Korea through 1999.

[507] Ibid.

[508] The KTX-1 project, led by Daewoo, is to be solely built by Korean aircraft firms. The KTX-2 trainer program is a joint development project between Samsung and Lockheed Martin.

[509] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998. Korea ranked 21st in aerospace in 1996 according to Michael Mecham, "South Korea Seeks Slice of World's Aerospace Pie," *Aviation Week & Space Technology*, Oct. 14, 1996, p. 42.

[510] Samsung officials, interview by USITC staff, Sachon, Korea, Apr. 30, 1998, and in written responses to USITC questions, Seoul, Korea, Apr. 27, 1998.

[511] Samsung, Hyundai, and Daewoo officials, interviews by USITC staff, Seoul, Sosan, and Changwon, Korea, Apr. 27-30, 1998.

[512] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[513] Korea Aerospace Industries Association official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[514] Korean Air officials, interviews by USITC staff, Seoul and Pusan, Korea, Apr. 27 and 29, 1998.

[515] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[516] Korean Air officials, interview by USITC staff, Seoul and Pusan, Korea, Apr. 27 and 29, 1998.

specialized parts manufacturer.[517] Notwithstanding the latter, industry sources indicate that the industry fully intends to market any aircraft it produces both domestically and internationally.[518]

Competitive Assessment

Availability of Capital

In light of the nation's recent economic difficulties, the Korean aerospace industry currently faces the challenge of adequate capital mobilization through a balance of indirect government resources and greater use of Korean firms' commercial fund-raising capabilities. Prior to the nation's economic crisis, the Korean Government announced plans to invest nearly $5 billion during 1996-2006 to build up Korea's aerospace industry.[519] Budgetary constraints have led to decreased public spending on the aviation sector, and in 1998 approved funding for KCDC was only 1 billion won ($770,000[520]), far below the 18 billion won ($14 million) originally requested.[521] At the same time, aerospace subsidies reportedly receive strong political and popular backing,[522] and the government is continuing its support for certain aerospace activities. For example, the Ministry of Commerce, Industry, and Energy spends approximately 30 billion won ($23 million) per year on approved R&D projects for the aerospace sector and will provide a total of 25 billion won ($19 million) over 4 years for R&D for the 100-seat aircraft program.[523] Further, the government has provided other means of financial support for the industry. In certain cases, aerospace companies are exempt from taxes on imports,[524] and with respect to a Korean regional aircraft program, the government will provide long-term, low-interest loans for up to 50 percent of the development costs.[525] As dual civil-military manufacturing facilities, Korean aerospace firms may receive further indirect benefits from military offsets, low-interest and no-interest government loans to the military sector,[526] and state funding for military research and aircraft development programs[527] through which the industry can gain transferable structural, integration, and design technologies.

Korea's aerospace sector enjoys greater commercial fund-raising capabilities than some Asian producers. As each major aircraft company belongs to one of Korea's large industrial groups or *chaebol*, they are able to borrow against a large asset base and spread risk over numerous industrial sectors, thus increasing financial stability and investor and lender confidence. Further,

[517] Korea Aerospace Industries Association and Ministry of Commerce, Industry, and Energy officials, interviews by USITC staff, Seoul, Korea, Apr. 27 and May 1, 1998.

[518] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[519] Mecham, "South Korea Seeks Slice of World's Aerospace Pie," p. 42.

[520] Calculated at an exchange rate of 1,300 won to the dollar.

[521] "Asian Crisis Bites Deep into Korean Aircraft Development Budget," *Flight International*, Apr. 15-21, 1998, p. 6.

[522] USDOC, ITA, "Aerospace Industry in South Korea," National Trade Data Bank, found at Internet address http://www.stat-usa.gov, retrieved Oct. 28, 1997.

[523] Ministry of Commerce, Industry, and Energy officials, interview by USITC staff, Seoul, Korea, May 1, 1998.

[524] Korean industry official, interview by USITC staff, Pusan, Korea, Apr. 29, 1998.

[525] Companies are expected to repay these loans only upon the successful development and marketing of a regional aircraft. Korean industry official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[526] Korean industry official, interview by USITC staff, Pusan, Korea, Apr. 29, 1998.

[527] Korean Government officials, interview by USITC staff, Seoul, Korea, May 1, 1998.

in response to the nation's financial crisis, the Korean Government loosened restrictions on foreign investment in Korean industries and has initiated a broad liberalization plan for the nation's financial markets. As a result, Korean aerospace entities will be able to draw on increased capital resources. In terms of risk-sharing partnerships, Korean aerospace companies currently absorb a share of nonrecurring costs of production as supplier-partners in subcontracting agreements with Western producers.[528] As the economic crisis has driven the prime interest rate to roughly 20 percent,[529] industry sources indicate a desire to find international participants willing to assume a like role in Korean aerospace projects.[530]

Industrial and Demographic Characteristics

Design and production capabilities

Korea's aviation industry lacks core competencies in design, systems integration, advanced manufacturing technologies, and the test and evaluation of finished products,[531] all necessary components of an aircraft program. Korean aircraft companies primarily manufacture lower value-added parts and subassemblies according to blueprint,[532] and thus have limited experience in the design, production, and evaluation of original products. Likewise, defense sector work has contributed little to the industry's foundation of basic technologies as most of the country's military aircraft programs have relied largely on technology borrowed from the United States.[533] Moreover, while collaboration with Western airframers has provided the Korean aerospace industry with training and technology transfer in basic process technologies, core technologies are not easily transferred.[534] To build up the industry's weak technological base, the Korean aerospace sector invests in R&D across diverse fundamental disciplines[535] and is exercising its indigenous design capabilities on domestic and cooperative projects whenever possible.[536] Nevertheless, one Korean producer estimates that it will take a minimum of 10 years for the Korean aviation sector to develop independent technologies for the design and production of commercial aircraft.[537]

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[528] Hyundai and Korean Air officials, interviews by USITC staff, Sosan and Pusan, Korea, Apr. 28-29, 1998.

[529] Korean Air and Samsung officials, interviews by USITC staff, Seoul and Sachon, Korea, Apr. 27 and 30, 1998; and Samsung officials, written responses to USITC questions, Seoul, Korea, Apr. 27, 1998.

[530] Samsung officials, interview by USITC staff, Sachon, Korea, Apr. 30, 1998.

[531] S.C. Kim, "Driving to Leading Technology in Future," *Business Korea*, Mar. 1996, p. 27; USDOC, ITA, "Korea--Aircraft Parts;" Jong Ha Kim, "Korea Maps Its World Challenge," *Interavia*, Jan./Feb. 1996, p. 14; and Korean and U.S. industry officials, interviews by USITC staff, Seoul, Korea, Apr. 27 and May 1, 1998.

[532] Korean industry officials, interview by USITC staff, Seoul, Korea, May 1, 1998; and Korean industry officials, written responses to USITC questions, Seoul, Korea, Apr. 27, 1998.

[533] Korean Government officials, interview by USITC staff, Seoul, Korea, May 1, 1998.

[534] Korean industry officials, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[535] Daewoo and Ministry of Commerce, Industry, and Energy officials, interviews by USITC staff, Changwon and Seoul, Korea, Apr. 30-May 1, 1998.

[536] Korean Air, for example, completed a full test cycle of design and production with the Chang Gong 91 general aviation aircraft, and the company's aerospace division has participated in the design of aircraft parts for Boeing, McDonnell-Douglas, and Dornier, in one case producing a design that was 30 percent below the contractor's weight specifications. Korean Air officials, interviews by USITC staff, Seoul and Pusan, Korea, Apr. 27 and 29, 1998.

[537] Korean industry officials, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

Though weak in terms of independent design capabilities, Korean firms have acquired a command of process technologies, and enjoy a reputation for quality components, parts, and subassemblies manufactured according to schedule.[538] Korean producers possess a high level of technical competence, particularly in the manufacture of structural components such as fuselage and wings and the assembly of airframe components and mechanical parts.[539] Although it is reported that the quality of Korean-manufactured parts is 20-25 percent below comparable U.S. products,[540] other Western and Asian industry sources indicate that Korean manufacturing of aircraft parts and subassemblies rivals that of Japan, considered to be the most capable parts supplier in Asia.[541] Korean firms have achieved the status of sole source supplier on parts for LCA, regional aircraft, and helicopters,[542] an indication of the global industry's confidence in Korea's technical capabilities with respect to aerospace manufacturing.

Manufacturing infrastructure

Korea's proficiency in manufacturing high quality parts with advanced machine processes is a function of the country's strong academic system and resulting pool of highly skilled workers and aerospace engineers. The majority of Korean universities offer aeronautical degrees, with approximately eight universities supporting full departments devoted to aerospace, and a number of colleges and high schools provide specialized training for aerospace technicians and line workers.[543] While industry sources note that Korea's educational system fulfills the needs of the industry both qualitatively and quantitatively,[544] Korean firms also utilize outside sources of training and talent. Over 80 percent of the nation's aerospace engineers are schooled or trained in the United States,[545] and while most technicians are educated in Korea, over 50 percent receive subsequent training abroad.[546] In addition, the industry recruits foreign manpower, and a number of aerospace engineers from the United States, France, and the former Soviet Union are employed in Korea's R&D centers and factories, including the Korea Aerospace Research Institute, Samsung, and Daewoo.[547]

[538] U.S. and Korean industry officials, interviews by USITC staff, Pusan and Sosan, Korea, Apr. 29-30, 1998.

[539] USDOC, ITA, "Korea--Aircraft Parts."

[540] Korea Institute for Industrial Economics and Trade, "Low Localization of Korea's Aircraft Parts Industry," *KIET Economic Review*, Feb. 1998, p. 23; and USDOC, ITA, "Korea--Aircraft Parts."

[541] U.S. and Korean industry officials, interviews by USITC staff, Seattle, WA, Feb. 10, 1998, and Pusan, Korea, Apr. 29, 1998.

[542] Korea is currently sole supply on Bell stringers, the Dash-8 empennage, wing structures for the 767-400ER, and flap track fairings for certain Boeing aircraft. Korean and U.S. industry officials, interviews by USITC staff, Seoul and Pusan, Korea, Apr. 27 and 29, 1998; and Samsung Aerospace Industries, press release, "Samsung Aerospace is to Exclusively Supply Wing Structures for Boeing's Newest Aircraft," Mar. 27, 1998, found at Internet address http://www.ssa.samsung.co.kr/news/nw980328.html.

[543] Korean Air officials, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[544] Korean Air and Samsung officials, interviews by USITC staff, Pusan and Sachon, Korea, Apr. 29-30, 1998.

[545] Korea Aerospace Research Institute, written responses to USITC questions, Seoul, Korea, Apr. 1998.

[546] Ibid.

[547] Kim, "Korea Maps Its World Challenge," p. 18; USDOC, ITA, "Aerospace Industry in South Korea;" and Korea Aerospace Research Institute, written responses to USITC questions, Seoul, Korea, Apr. 1998.

The Korean aircraft industry further benefits from advanced transportation and communications systems and well-developed support industries.[548] Labor costs are low relative to the United States, Western Europe, and Japan, and have become particularly competitive due to the economic crisis.[549] With respect to manufacturing sites, Samsung, Daewoo, Korean Air, and Hyundai maintain fully automated, modern, and well-organized production facilities characterized by sophisticated machine tools including 5-, 6-, and 7-axis CNC machines. Such equipment is similar to that found in Western LCA manufacturers' facilities. Factories are computerized, in some cases paperless,[550] and equipped to perform a wide range of processes such as metal forming, chemical bonding, painting, wind tunnel tests, and heat treatment of metals. Korean aerospace entities invest heavily in the supply and maintenance of these facilities. Korean Air has invested a total of $1.5 billion in its Pusan facilities, including $400 million in machinery,[551] while Hyundai spent over $400 million to erect its Sosan plant for production of the 717-200 wing.[552] In addition, while Korean aircraft companies import most advanced equipment from the United States and Europe, the industry sustains a moderate degree of self-sufficiency in machine tool production.[553]

Similar conditions exist with respect to the procurement of raw materials. Due to insufficient certification requirements governing domestic suppliers, the Korean industry sources most materials for its subcontract programs from abroad.[554] However, a select number of local suppliers have been certified by Western manufacturers allowing the use of local inputs in the production of parts and components for Western aircraft;[555] and Korea intends to increase gradually the use of domestic suppliers to reduce costs incurred through shipping and currency fluctuations.[556]

With respect to R&D, each of the major firms retains independent research facilities involved in design and product development. In addition, the Korea Aerospace Research Institute (KARI), a national center that conducts aeronautical R&D and provides technical support to the aviation industry, maintains a low-speed wind tunnel, test facilities for assembly, integration, and aeropropulsion, and a structure and flight dynamics laboratory.[557] KARI and the industry's R&D facilities are presently researching a number of indigenous innovations, including designs for an unmanned aerial vehicle, a twin-engine composite aircraft, the 100-seat turbofan-powered aircraft,

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[548] Korea Aerospace Industries Association official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998; and Korea Institute for Industrial Economics & Trade, materials provided to USITC staff, Seoul, Korea, Apr. 1998.

[549] Samsung officials, interview by USITC staff, Sachon, Korea, Apr. 30, 1998.

[550] A paperless factory is one which relies on computer terminals dispersed on the factory floor to access plans, schematics, and work reports on projects underway. It is a powerful tool for the management of workflow and quality assurance as workers and supervisors in all areas of the factory can access the computer to check the status and position of a particular structure or assembly at any point in the production and delivery processes.

[551] Korean Air officials, interview by USITC staff, Pusan, Korea, Apr. 29, 1998.

[552] Lewis, "Upwardly Mobile," p. 33; and Bruce Dorminey, "Hyundai Opens 717 Wing Assembly Plant," *Aviation Week & Space Technology*, June 8, 1998, p. 33.

[553] Daewoo, Samsung, and Hyundai, for example, have several years of experience in the fabrication of 3-axis machines and, in some cases, export to the United States. Daewoo officials, interview by USITC staff, Changwon, Korea, Apr. 30, 1998.

[554] Korean industry officials, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[555] Ibid.

[556] Korean Air and Hyundai officials, interviews by USITC staff, Seoul and Sosan, Korea, Apr. 27-28, 1998.

[557] Korea Aerospace Research Institute, materials provided to USITC staff, Seoul, Korea, Apr. 1998.

and gas turbine engines.[558] However, the ability of Korea's research institutes to generate independent designs and a comprehensive development program for commercial aircraft has yet to be fully tested. How Korea performs with the KTX-1 and KTX-2 programs will likely provide greater evidence as to the capabilities of Korea's R&D facilities with respect to a comprehensive aircraft program.

Domestic market conditions

While the Korean industry has built a solid foundation upon which to expand into more complex projects, the nation's domestic market is too small to support a regional aircraft program.[559] Though Korea's airlines see a need for a 100-seat regional jet to increase frequencies on medium-distance routes such as Seoul-Tokyo and Seoul-Singapore,[560] sources in the manufacturing sector estimate that the country would need to sell a minimum of 200-300 aircraft to recoup full development costs.[561] Thus, without a guaranteed domestic sales base, the Korean aerospace industry would need to produce an economically and technically superior product for sale in foreign markets.

Korea's alternative, an option the industry has been pursuing consistently, is cooperation with foreign partners that can provide Korea with supplemental markets. At the same time, a number of factors may contribute to growth of the domestic market. In particular, Korea recently signed an Open Skies initiative with the United States. Industry sources feel this may lead to increased external and internal frequencies[562] and, consequently, greater demand for aircraft. More importantly, Korea is in the process of revising the country's strict aviation regulations.[563] As with deregulation in the United States, which led to a surge in demand for smaller aircraft, Korean industry sources estimate that Korean deregulation will lead to a regeneration of the domestic market, specifically a niche market for regional aircraft that could support the launch of a domestic aircraft program.[564] Korean industry analysts are also considering the possibility of greater demand for medium-sized aircraft due to increased economic cooperation or possible reunification with North Korea.[565]

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[558] Ibid.

[559] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998; and Korea Institute for Industrial Economics & Trade, materials provided to USITC staff, Seoul, Korea, Apr. 1998.

[560] Korean airline official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[561] Korean industry official, interview by USITC staff, Sachon, Korea, Apr. 30, 1998.

[562] Korean airline official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998. See chapter 6 for a discussion of Open Skies agreements.

[563] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[564] Ibid.

[565] Ibid.

Corporate Characteristics

While Korea benefits from a market-oriented corporate system, decisions of the nation's aerospace firms are not always based on solid economic principles. For example, rather than basing decisions to enter the aerospace industry on the demand conditions prevailing in the market, the participation of certain *chaebol* in aerospace appears to be based on the desire to parallel the industrial structure of other conglomerates.[566] This has led to an overabundance of firms in the industry[567] and a lack of extant capacity utilization. Further, the lack of consensus among Korea's major aerospace firms has been an impediment to the development of a national aerospace program, as infighting among the aircraft companies has hindered the development of certain aerospace projects.[568] To speed Korea's recovery from the economic crisis, the government is pushing reform of the nation's industrial conglomerates. Korean industry sources anticipate that *chaebol* restructuring may facilitate industrial cooperation and participation based on market principles.[569] Industry sources predict that at least one firm will leave the aircraft industry as Korea's *chaebol* are forced to reevaluate the profitability and feasibility of business sectors.[570] Thus, corporate restructuring could result in a more competitive business environment and, consequently, lead to improved financial strength, greater specialization, and increased competitiveness in the Korean aerospace sector.

Program Characteristics

Experience in marketing products abroad, the nation's history of aircraft maintenance, repair, and overhaul, and the government's increased focus on international standards and safety give the Korean aerospace sector an advantage over other Asian competitors in selling an indigenous product. Each of Korea's aircraft entities can draw on their parent company's reputation, financial base, and marketing skills, as well as the nation's facilities and capabilities in aircraft repair and maintenance. Moreover, as the Korean industry considers the regional jet project an export program[571] and wants to participate in all processes of aircraft production including quality assurance and after-sales service, sources indicate that the industry is willing to undertake the cost and commitment necessary to support its product on the global market.[572] Concerning product safety, the Korean industry realizes that marketability depends upon certification from the FAA or West European Joint Aviation Authorities (JAA),[573] and Korea is moving to adopt globally accepted standards and regulations which would facilitate Western certification of an indigenous aircraft. In October 1997, the Korea Civil Aviation Bureau, the regulatory body responsible for airworthiness and type certification, signed a Memorandum of Agreement with the FAA, one of the preliminary steps to conclusion of a Bilateral Aviation Safety Agreement. Under the

[566] Ibid.

[567] Korean industry officials, interviews by USITC staff, Seoul and Pusan, Korea, Apr. 27 and 29, 1998; and Korea Institute for Industrial Economics and Trade, "Korea's Aircraft Industry: Using Strategic Alliances to Reach a New Level of Sophistication," *KIET Economic Review*, Sept. 1997, p. 15.

[568] Paul Lewis, "S (sic) Koreans Discuss Link-up," *Flight International*, Jan. 29-Feb. 4, 1997, p. 20.

[569] Korean aerospace industry analyst, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[570] Korean and U.S. industry officials, interviews by USITC staff, Seoul and Pusan, Korea, Apr. 27-May 1, 1998.

[571] Korean Government and industry officials, interviews by USITC staff, Seoul, Korea, Apr. 27-May 1, 1998.

[572] Korean industry officials, interviews by USITC staff, Seoul, Korea, Apr. 27, 1998.

[573] Korean Air and Samsung officials, interviews by USITC staff, Seoul, Korea, Apr. 27, 1998.

agreement, the FAA is to provide the Korean aerospace industry with technical assistance and training in aviation-related disciplines.[574] Just one month after the agreement was signed, Korean officials underwent an "Aircraft Certification Indoctrination Course" under the direction of the FAA.[575]

Arrangements with Foreign Aerospace Entities

Gaps in technology, the amount of investment required to boost Korea's basic core capabilities, and uncertainty over the potential size of the domestic market for regional transport necessitate foreign participation in a Korean commercial aircraft program. The industry draws on a number of incentives to attract foreign interest in collaborative arrangements. Comparatively low labor costs and the Korean aerospace industry's reputation for well-manufactured parts and components, for example, have promoted long-term cooperative agreements between Korean aircraft companies and foreign, primarily Western, aerospace entities. In addition, though Korea's domestic market for aircraft lacks the gross potential of the Chinese market, demand for LCA is relatively high[576] and, as noted, may increase through regulatory reform. Thus, market access is an incentive for additional collaborative arrangements. Mandatory offsets in the military sector and offsetlike agreements generated by corporate connections and personal links between Korea's airlines and certain manufacturers have brought further production work and related training and technology to Korea's aerospace sector.[577]

Korean industry sources note that local development of the Korean aircraft industry has been minimal, with the majority of aircraft technology transferred through collaboration with international aerospace entities.[578] Present and former contracts with foreign producers for the licensed production of F-16 military fighters, MD-500, Bell 412, and Sikorsky Blackhawk helicopters, and numerous production agreements with Boeing and Airbus for parts, components, and subassemblies have provided Korea the inroads through which to expand the nation's repair and maintenance base into a successful parts manufacturing sector. In addition, international collaborative arrangements have provided the industry with a steady source of income. For example, 80 percent of locally produced aircraft parts for civilian use are exported,[579] and the total value of Korean exports of aircraft parts grew by over 55 percent during 1990-95.[580] Boeing alone absorbs approximately $150 million in Korean-made aircraft components and expects its purchases to reach roughly $250 million by 2000.[581] At the same time, while licensed production and subcontracting agreements have provided the industry with training, manufacturing technologies, and extensive experience, cooperation has done little to advance the nation's independent design capabilities or advanced technical skills, which are necessary tools for a domestic aircraft program.

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[574] U.S. Government official, correspondence with USITC staff, May 28, 1998.

[575] Ibid.

[576] U.S. industry officials, interview by USITC staff, Seattle, WA, Feb. 10, 1998.

[577] Korean and U.S. industry officials, interviews by USITC staff, Changwon and Seoul, Korea, Apr. 30-May 1, 1998; and USDOC, ITA, "Korea--Aircraft Parts."

[578] Korean industry official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.

[579] USDOC, ITA, "Korea--Aircraft Parts."

[580] Exports of aircraft parts totaled $211 million in 1995. Korea Institute for Industrial Economics and Trade, "Low Localization of Korea's Aircraft Parts Industry," *KIET Economic Review*, Feb. 1998, p. 23.

[581] U.S. industry official, interview by USITC staff, Seoul, Korea, May 1, 1998.

Korean Government and industry representatives indicate that Korea has no desire to build an aircraft alone,[582] but seeks foreign contributions of technology, money, and market.[583] Moreover, the aviation community insists that a U.S. or European partner is fundamental to the initiation of an aircraft project;[584] however, despite several attempts, Korea has failed to find a suitable partner for its regional aircraft program. Samsung Aerospace's efforts in 1996 to invest up to $150 million to revive Fokker from bankruptcy and use the Dutch aircraft maker's proposed 130-seat aircraft program as a venue for its own ambitions in the regional jet market[585] failed because of lack of support from the Korean Government and the decision of one of Fokker's suppliers to terminate wing production for the company's regional jets.[586] In April 1997, KCDC signed a Memorandum of Understanding with AI(R), a joint venture operated by Aérospatiale (France), Alenia/Finmeccanica (Italy), and British Aerospace, for collaboration on the AI(R) 70-seat regional aircraft.[587] Despite estimations of a market for aircraft of this size and the Korean industry's willingness to fund a portion of the program's estimated $1 billion development costs, AI(R) chose to drop the 70-seat jet project in December 1997. Korea's subsequent talks with EMBRAER (Brazil), Israel Aircraft Industries, and Fairchild-Dornier[588] (United States) over the joint development and production of medium-sized aircraft have yet to result in any formal agreement. The Korean aviation community strongly desires to participate in an aircraft program, yet reports indicate that Korea will scrap the aircraft development project if suitable foreign partners cannot be found.[589]

Indonesia

Background

Indonesia entered the civil aviation sector in the early 1970s, building upon the nation's existing facilities for military aircraft production. The government's identification of aerospace as one of the key sectors to lead the nation into industrial transformation prompted the industry to adopt a four-stage development plan, intended to quickly transform the country into a high-level designer and manufacturer of aircraft.[590] Stage 1, which called for the licensed manufacture of aircraft from existing designs, got underway with two agreements concluded in 1975, one with Construcciones Aeronáuticas S.A. (CASA) of Spain to build the CN-212 Aviocar 26-seat twin turboprop, and the other with Messerchmitt-Bölkow-Blohm GmbH (MBB) of Germany for the licensed production of the BO-105 helicopter. In 1979, the Indonesian industry entered the

[582] Korean Government and industry officials, interviews by USITC staff, Seoul, Pusan, and Changwon, Korea, Apr. 27-May 1, 1998.

[583] Korean Government and industry officials, interviews by USITC staff, Sachon and Seoul, Korea, Apr. 30-May 1, 1998.

[584] Korean industry officials, interviews by USITC staff, Seoul, Korea, Apr. 27, 1998.

[585] Charles Alcock, "Samsung Bid Failure May Terminate Fokker," *Aviation International News*, Jan. 1, 1997, p. 16.

[586] A particular concern of the Korean Government was that other Korean aerospace firms participate in the company resulting from the proposed buy-out. John D. Morrocco and Michael Mecham, "Clock Runs Out on Fokker Rescue," *Aviation Week & Space Technology*, Dec. 9, 1996.

[587] Paul Lewis, "S (sic) Korea Signs AI(R) JET Deal," *Flight International*, Apr. 16-22, 1997, p. 7.

[588] Fairchild-Dornier, which currently produces small turboprop and turbofan aircraft, is further discussed in Chapter 6.

[589] Song Jung-tae, "ROK May Abandon Plan to Develop Medium-Size Plane," *Korea Herald*, Mar. 29, 1998, p. 12.

[590] Paul Lewis, "The Planning Man," *Flight International*, June 19-25, 1996, pp. 9-12.

codesign and manufacturing stage (stage 2), with a second arrangement with CASA to develop and coproduce the CN-235, a 35- to 44-seat multipurpose turboprop, under the 50-50 joint venture Aircraft Technology Industries (Airtech). Stage 3 of the industry's advancement, calling for complete autonomy in the design and production of an indigenous aircraft, is represented by Indonesia's first nationally produced civil aircraft, the N-250 regional turboprop incorporating fly-by-wire technology, which emerged as a prototype in November 1994. The final stage of Indonesia's aerospace development program incorporates advanced R&D for the design and manufacture of a regional jet. Indonesia's aircraft industry has entered this fourth stage with plans to develop a family of aircraft starting with the N-2130 jet-powered airliner. Presently, the Indonesian aircraft industry faces serious economic and political uncertainty because of the region's financial crisis. Nonetheless, Indonesian industry officials indicate that the aircraft industry is proceeding into the preliminary and detail design stages of the N-2130 program.[591]

Manufacturers and Major Products Produced

Indonesia's sole aircraft company is the state-owned enterprise PT Industri Pesawat Terbang Nusantara (IPTN), formally established in 1976 by the Indonesian Government to consolidate the country's aerospace facilities into one company (table 5-6). IPTN serves both the military and commercial aerospace markets, with work for the commercial transport sector distributed among the following divisions: the Fixed Wing Division for the production of aircraft; the Rotary Division, which houses the licensed production of helicopters; the Fabrication Division, involved in production of components, tools, and jigs; and the Universal Maintenance Center for the overhaul and repair of engines. Though IPTN has long supported a large aerospace work force, employees' work hours have been cut to reduce expenditures and the company plans to lay off 3,000 workers in 1998.[592]

Table 5-6
Indonesia: Principal aerospace manufacturers and products

Company	Founded	Facilities	Staff	Sales (millions)	Major commercial products
PT Industri Pesawat Terbang Nusantara	1976	Bandung Additional factories in Tasikmalaya and Batu Poron	16,000 -- total 1,500 -- engineers	$2,464[1] (1976-97)	Aircraft: • CN-212 • CN-235 • N-250 Aircraft parts: • Pressure bulkhead -- 757 • Flap carriage -- A340

[1] Total sales since inception as reported by the Indonesian press. Financial data on the annual sales of IPTN are unavailable. "Indonesia: Paper Views Controversy over Aircraft Industry," *Jakarta Republika*, Feb. 5, 1998, FBIS translated text FBIS-EAS-98-036.

Source: Compiled from various sources by USITC staff.

[591] Indonesian Government and industry officials, interviews by USITC staff, Jakarta, Indonesia, May 14, 1998.

[592] "IPTN Akan PHK 3.000 Karyawan Sesuai Rencana Restruckturisasi (In Line with Restructuring Plan, IPTN Will Lay off 3,000 Employees)," *Bisnis Indonesia*, Apr. 21, 1998, unofficial translation by the U.S. Embassy, Jakarta; and "Indonesia: Aircraft Plant Reduces Salaries, Operating Hours," *Jakarta Gatra*, May 23, 1998, FBIS translated text FBIS-EAS-98-146.

In addition to the production of components for its own projects, IPTN manufactures parts for LCA under contract from Boeing and Airbus (table 5-6). IPTN also produces three distinct twin-engined turboprops: the CN-212 Aviocar utility turboprop, CN-235 short-range aircraft, and the N-250 (table 5-7). Development for the N-250 began in 1989, and the 50-seat N-250-50 made its first flight in August 1995. The N-250-100, equipped with seating capacity for 64-68 passengers, followed in December 1996. In response to funding constraints and market preferences, IPTN has temporarily suspended additional plans to manufacture a third derivative,

Table 5-7
Indonesia: Passenger aircraft programs

Aircraft	Origin	Seats	Range[1]	Engine	Certification	Units sold
CN-212-100 CN-212-200	Licensed production of CASA 212	26	220 (CN-212-200) (Max. payload) 950 (CN-212-200) (Max. fuel)	AlliedSignal TPE331-10R-512C	Unknown	95[2]
CN-235-10 CN-235-110 CN-235-220 CN-235-QC	Airtech	44	810 (CN-235-110) 825 (CN-235-220) (Max. payload with 45 min. reserves) 2,110 (CN-235-110) 1,974 (CN-235-220) (Max. fuel)	GE CT7-7A (CN-235-10) GE CT7-9C (CN-235-110)	1986 Spanish and Indonesian certification (CN-235-10) 1986 FAA FAR Parts 23 and 121 (CN-235-10) 1992 Indonesian certification (CN-235-QC) 1995 JAA Rules Part 25 (CN-235-110)	28[3]
N-250-50 N-250-100 N-270	IPTN	50-54 (N-250-50) 64-68 (N-250-100) 70-76 (N-270)	686[4] (N-250-50) (Max. payload) 800 (N-250-50) (With 50 passengers)	Allison AE 2100C	Late 2000 Goal for Indonesian certification Late 2000 Goal for FAA/JAA certification	None
N-2130-100 N-2130-200	IPTN	104-114 (N-2130-100) 122-132 (N-2130-200)	1200[4] (Basic gross weight) 1600[4] (Increased gross weight)	Not determined	Early 2004 Goal for Indonesian, FAA, and JAA certification	Under development

[1] Expressed in nautical miles.
[2] As of Dec. 1997.
[3] As of Jan. 1998.
[4] Estimated.

Source: Compiled from various sources by USITC staff.

the N-270, which will carry 70-76 passengers.[593] Original plans called for this stretched version, aimed at the U.S. market, to be assembled and marketed by IPTN in the United States, with delivery of the first aircraft in early 2000.[594]

Development is currently underway for a family of turbofan-powered regional aircraft known as the N-2130. Originally conceptualized in three versions, an 80-passenger model was abandoned in early 1997 following consultations with international and domestic customers. The remaining Series 100 and Series 200 models will require an investment of approximately $2 billion, to be raised from private sources and income from the N-250.[595] In the face of increased competition from other Asian consortia in the 100-seat jet market, IPTN opted to speed up development by 2 years, leading to planned production of the first N-2130 aircraft by 2002 and deliveries beginning in 2004.[596]

Goals of Indonesia's Aerospace Industry

While IPTN's foremost concern is surviving the nation's financial crisis,[597] the industry's long-term goals remain focused on the production and marketing of a family of passenger aircraft. IPTN aims to secure FAA and JAA certification for the N-250 in order to sell the turboprop in the United States and Europe.[598] In addition, despite a possible postponement of 2-3 years, Indonesia intends to continue development of the N-2130 regional jet and looks to market the aircraft throughout Asia.[599] Indonesia's objectives in pursuing a national aircraft program are threefold--to improve Indonesia's transport infrastructure while reducing the country's dependency on imported aircraft, to provide a source of jobs for Indonesia's large work force, and to accelerate the nation's industrial development via the promotion of high technology industries such as aerospace.[600] With respect to the latter, Indonesian Government officials state that in order to reduce the time required for catch-up growth, the Indonesian aircraft industry must work in reverse, progressing from marketing of a complete product to gains in basic research.[601] There is additional interest in some sectors to employ this method to develop gas-turbine production capability to complement the national aircraft program.[602]

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[593] R. Randall Padfield, "In the Works," *Aviation International News*, Aug. 1, 1998, p. 76.

[594] Kirby J. Harrison, "AMRAI Forms Task Force to Bolster N-250 Program," *Aviation International News*, Mar. 1, 1997, pp. 46.

[595] Max Kingsley-Jones, "Commercial Aircraft of the World, Part 2: The Large Airliners," *Flight International*, Sept. 3-9, 1997, p. 48.

[596] Lewis, "Planning Man" p. 12; and Kingsley-Jones, "Commercial Aircraft, Part 2," p. 48.

[597] Ministry of State for Research and Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

[598] Agency for the Assessment and Application of Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

[599] Indonesian Government and industry officials, interviews by USITC staff, Jakarta, Indonesia, May 14, 1998.

[600] Agency for the Assessment and Application of Technology and PT Dua Satu Tiga Puluh officials, interviews by USITC staff, Jakarta, Indonesia, May 14, 1998.

[601] Ministry of State for Research and Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

[602] Ibid.; "Indonesia's IPTN Wants Gas Turbine Engine Capability," *Flight International*, Nov. 26-Dec. 2, 1997, p. 28; and "IPTN Moves to Produce Engine in Grand Aviation Designs," *Jakarta Post*, found at Internet address http://www.newsedge, posted June 28, 1997, retrieved July 1, 1997.

Availability of Capital

Shortage of capital is currently the greatest obstacle facing the Indonesian aviation industry. Indonesia's aerospace sector has traditionally received strong financial and political support from the Indonesian Government. IPTN's Bandung facilities were built with direct subsidies, and the government has invested a total of $2 billion in IPTN over the years, including $650 million in state funds for the N-250 regional aircraft.[603] Indonesian officials indicate that the government will continue to back the civil aircraft sector.[604] However, as part of the nation's obligations under the International Monetary Fund's restructuring program, Indonesia has agreed to cease all monetary support for national aircraft programs.[605] The next likely source of funding, the nation's banking sector, is unwilling to invest in IPTN due to limited knowledge of the aircraft industry and a preference for traditional business ventures.[606] IPTN's attempts to enlist international partners willing to accept a risk- or revenue-sharing role in national aircraft projects have failed to result in concrete agreements.[607]

At the same time, the industry receives government support for aerospace development through research grants targeted at Indonesia's industrial sector. The Ministry of State for Research and Technology provides funding for approved projects submitted by the aerospace industry that entail basic research or provide spillover effects to other industries.[608] In addition, though industry officials point to the aerospace sector's lack of skill in finding and attracting varied sources of capital,[609] the industry has made some progress in securing alternate funding. In 1996, PT Dua Satu Tiga Puluh (DSTP) was founded to function as IPTN's fund-raising agency for the N-2130.[610] DSTP is to raise the $2 billion[611] needed for the design, prototyping, and certification of the aircraft through the private investment of individuals, corporations, and foundations, and an initial shares offering to the Indonesian public.[612] DSTP officials indicate that the company is considering listing its shares on the Jakarta Stock Exchange in 5-6 years and may eventually allow

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603 David McKendrick, "Obstacles to 'Catch-up': The Case of the Indonesian Aircraft Industry," *Bulletin of Indonesian Economic Studies*, vol. 28, No. 1, Apr. 1992, p. 41; Michael Mecham, "IPTN Woos Foreign Firms for Regional Transports," *Aviation Week & Space Technology,* July 1, 1996, p. 66; and Lewis, "Planning Man," pp. 11-12.

604 Indonesian Government official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

605 "Indonesia Agrees to IMF Restructuring Plan," *Los Angeles Times*, found at Internet address http://www.newsedge, posted Jan. 15, 1997, retrieved Jan. 15, 1997.

606 Indonesian Government official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

607 IPTN reportedly initiated discussions in early 1998 with Hindustan Aeronautics of India, Aerospace Industrial Development Corporation of Taiwan, and the Sultan of Brunei for funding of IPTN aircraft programs. "IPTN Tries to Woo N2130 Support," *Flight International*, Mar. 4-10, 1998, p. 9; and Margot Cohen, "Winging It," *Far Eastern Economic Review,* January 29, 1998, p. 52.

608 Ministry of State for Research and Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

609 Indonesian Government official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

610 DSTP was founded by former President Suharto in a private capacity. Paul Lewis, "Jet Setting," *Flight International*, June 19-25, 1996, p. 28.

611 Additional costs are the responsibility of IPTN. PT Dua Satu Tiga Puluh officials, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

612 Ibid.

foreign investment.[613] As of September 1997, DSTP raised 25 percent of the N-2130's development costs.[614] However, the ability of DSTP to meet its goal of raising $2 billion by 2002 is uncertain. DSTP officials indicate that the country's financial situation has severely inhibited fund-raising abilities,[615] and complaints over the public shares offering have reportedly prompted IPTN to call for a review of the company's methods of capital mobilization.[616]

Industrial and Demographic Characteristics

While IPTN's structured approach to aircraft development has made Indonesia a manufacturer of airframes in only 20 years, the Indonesian industry currently supports few backward or forward linkages.[617] The industry further lacks a comprehensive understanding of the elements constituting an aircraft program[618] and has developed capabilities that are disconnected.[619] For example, while the industry supports basic design capabilities,[620] production processes and management skills are weak.[621] Likewise, IPTN has experience in manufacturing whole aircraft, but lacks the ability to consistently produce reliable aircraft parts and components.[622]

In terms of infrastructure, the absence of a local supplier base has left IPTN largely dependent on foreign-supplied components[623] and extremely vulnerable to currency depreciations. With respect to the N-250, for example, IPTN has relied heavily on imported technology for several of the aircraft's advanced components, including major subsystems. In terms of dollar value, 39 percent of the N-250's content comes from the United States and 22 percent from Western Europe.[624] IPTN must also source machinery from overseas suppliers due to limited capabilities in tool production and a desire for the most advanced technological resources available. The company has invested heavily in state-of-the-art machinery and computer equipment for its facilities, including production tooling for the N-250 line.[625] While Indonesia's use of a foreign supply network for capital goods has provided the industry with sophisticated equipment, this approach has diverted resources from the development of other fundamental capabilities.

Labor constraints are an additional factor inhibiting the competitiveness of Indonesia's aircraft industry. Relative to the country's large population, Indonesia draws from a limited pool of skilled

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[613] Ibid.
[614] Ibid.
[615] Ibid.
[616] "IPTN to Replace All Foreign Engineers Soon," *Jakarta Post*, May 2, 1998.
[617] "IPTN Develops High-Tech Aerospace Industry," *Korea Herald*, found at Internet address http://www.newsedge, posted Aug. 18, 1997, retrieved Aug. 19, 1997. Backward linkages entail relationships between an industry and its suppliers, for example, suppliers of raw materials, avionics, engines, and components to the aerospace sector. Forward linkages are relationships between a sector and its related consuming industries. In the aircraft manufacturing industry, this may include passenger airlines, cargo and parcel delivery companies, and flight training operations.
[618] Indonesian Government officials, interviews by USITC staff, Jakarta, Indonesia, May 14, 1998.
[619] Indonesian Government official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[620] Asian aerospace industry official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.
[621] Indonesian Government official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[622] U.S. industry officials, interview by USITC staff, Seattle, WA, Feb. 10, 1998.
[623] Agency for the Assessment and Application of Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998; and Lewis, "Planning Man," p. 11.
[624] Mecham, "IPTN Woos Foreign Firms," p. 65.
[625] McKendrick, "Obstacles to Catch-up," pp. 41, 48; and Lewis, "Jet Setting," p. 28.

labor,[626] and productivity and efficiency are low compared to Western nations.[627] Indonesia also lacks the educational facilities to produce a sufficient number of engineers. In contrast to the United States, which graduates approximately 5,000 aerospace engineers per year,[628] Indonesia has only one university with a program in aeronautics that graduates roughly 75 students per year.[629] In an effort to buoy its aircraft work force, the Indonesian industry has again turned to foreign sources, employing engineers from Australia, Europe, and New Zealand.[630] IPTN also has a scholarship program to educate Indonesian engineers at U.S. and European universities,[631] and over 2,000 of the company's employees have been sent abroad to study the latest aircraft technology and management techniques.[632] While both practices have provided the industry with a much needed base of Western technology, the nation's financial crisis forced IPTN to lay off its entire expatriate staff of 200 engineers working on the CN-235 and N-250 programs[633] and has severely restricted the financing of employees' overseas education.[634]

Like China, Indonesia benefits from a large potential market for aircraft. The country's vast archipelago of some 17,000 islands, a population ranked fourth globally, and historically dynamic GDP growth[635] make development of regional air transport a viable business. Further, government influence in purchasing decisions has provided Indonesia with a captive market in the military and state-owned airlines. The state reportedly oversees all aircraft purchases and has limited imports, leaving Western aircraft producers with a defined market share and Indonesian airlines with little control over the composition of their fleets.[636] At the same time, while industry sources confirm the existence of a potential Indonesian market for regional aircraft,[637] opinions differ as to the size of this market, an important factor in IPTN's ability to achieve the economies of scale necessary to produce an international competitive aircraft. A feasibility study by IPTN projects that 25 percent of global demand for regional jet aircraft of approximately 100 seats will be met through sales of the N-2130, specifically 168 units domestically and 632 units internationally during 2005-2025.[638] These estimates are currently under review by other Indonesian aerospace officials,[639] and Western estimates for the total market for 100-seat jets in Indonesia do not support IPTN's conclusions.[640]

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[626] Korean industry official, interview by USITC staff, Seoul, Korea, Apr. 27, 1998.
[627] Indonesian Government official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[628] Ministry of State for Research and Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[629] Ibid.
[630] U.S. Government officials, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[631] Ministry of State for Research and Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[632] "IPTN Develops High-Tech Aerospace Industry," *Korea Herald*.
[633] "IPTN to Replace All Foreign Engineers Soon," *Jakarta Post*.
[634] Ministry of State for Research and Technology official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[635] Although growth of the Indonesian economy is expected to slow significantly due to the present financial crisis in Asia, growth rates during the past decade have averaged about 7 percent annually.
[636] "Indonesian Aerospace Ready to Do Business," *Aviation Week & Space Technology*, Apr. 22, 1996, p. S1; and McKendrick, "Obstacles to 'Catch-up,'" p. 42.
[637] Korean industry and Singapore Government officials, interviews by USITC staff, Seoul, Korea and Singapore, Apr. 27 and May 12, 1998.
[638] Indonesian industry official, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[639] Ibid.
[640] U.S. industry sources, electronic mail to USITC staff, Mar. 3, 1998.

Corporate Characteristics

One of the Indonesian industry's greatest weaknesses is government control of the aerospace sector. The decisions of IPTN have been based primarily on the interests of a few highly influential political figures, and the company's financial performance has depended largely on government support; as a result, it is questionable whether IPTN or an Indonesian aircraft sector would exist had market forces been allowed to govern the industry.[641] In addition, as a government-owned enterprise, IPTN is not required to disclose financial data on sales, investment, R&D expenditures, and capitalization. As Indonesia's harsh economic conditions have prompted IPTN to look abroad for financial relief for its ailing aircraft programs, the resulting lack of transparency severely impedes the company's ability to attract potential investors and risk-sharing partners for aircraft programs.

Program Characteristics

Indonesia currently faces significant obstacles concerning the overseas sales of its products including the lack of internationally recognized airworthiness standards and insufficient resources to market and support its aircraft globally. The current financial crisis and IMF restrictions have limited the industry's options for financing overseas sales of aircraft. Moreover, IPTN has regularly resorted to barter trade to secure exports of its products.[642] Though IPTN has formed two subsidiaries, U.S.-based American Regional Aircraft Industry (AMRAI) and the European Regional Aircraft Industry in Germany, for sales and support assistance in the United States and Europe, the company will need to strengthen its product support infrastructure and marketing abilities in order to sell its planned family of aircraft globally.

Further, the absence of a bilateral airworthiness agreement with the United States precludes IPTN-made aircraft from operating in countries that require adherence to FAA standards. The lack of FAA approval has reportedly hurt sales of the CN-235[643] and could seriously affect exports of the N-250 and N-2130, both of which are targeted at foreign markets. Although Indonesian Government and aerospace officials acknowledge the necessity of Western certification,[644] U.S. industry sources indicate that Indonesia continues to exhibit a lack of understanding regarding the purpose and correct implementation of FAA safety and quality assurance standards and regulations despite several years of negotiations.[645]

Arrangements with Foreign Aerospace Entities

Few incentives exist to attract foreign entities to the Indonesian aircraft sector; thus, the nation's ability to gain experience and technology transfer through foreign collaboration is limited. As market access is the primary incentive for foreign aerospace companies to provide training and technical assistance to Asian nations, uncertain projections concerning the potential demand and

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[641] See, for example, Pang Eng Fong and Hal Hill, "Government Policy, Industrial Development and the Aircraft Industry in Indonesia and Singapore," ch. 9 in *Industry on the Move: Causes and Consequences of International Relocation in the Manufacturing Sector* (Geneva: International Labour Office, 1992), pp. 244-245.

[642] Lewis, "Planning Man," p. 10.

[643] Ibid.

[644] Indonesian Government and industry officials, interviews by USITC staff, Jakarta, Indonesia, May 14, 1998.

[645] U.S. Government officials, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.

stability of the Indonesian market have contributed to the low number of subcontracts placed in Indonesia. Further, though IPTN has gained experience in assembly of small aircraft through its arrangements with CASA, lingering issues over quality assurance and gaps in basic managerial, organizational, and technical skills are unlikely to be resolved without greater cooperation with established LCA producers.

Singapore

Background

Singapore became involved in parts manufacturing and aircraft servicing in the 1970s following the government's designation of the aerospace industry as a priority area for development.[646] Primarily supportive of the military sector, an influx of multinational firms brought work to the commercial sector in the 1980s.[647] The commercial aircraft industry grew quickly with two events in 1981--the opening of Changi International Airport, which expanded Singapore's capacity as an international servicing agent, and the signing of a BAA with the United States, which opened the way for international certification of locally manufactured parts and components.[648]

Manufacturers and Major Products Produced

Singapore's largest aerospace company, Singapore Technologies Aerospace (STAe), provides repair, maintenance, modification, refurbishment, and upgrade services for airframes, engines, subsystems and components in the military and commercial aerospace sectors (table 5-8). STAe currently operates under the engineering group Singapore Technologies Engineering (ST Engg). Aerospace manufacturing activities, formerly the responsibility of STAe, were separated from the company in 1995 and now fall under the investment holding company Singapore Technologies Precision Engineering (STPE). ST Engg and STPE both exist under the corporate holding group Singapore Technologies Pte Ltd., part of Temasek Holdings, which in turn falls under the Ministry of Finance of the Singaporean Government. STPE is not publicly listed, and although ST Engg listed shares on Singapore's stock exchange in December 1997, the government still controls a large portion of the company.[649] In addition to these domestic firms, the aerospace industry further supports a number of joint ventures and multinational corporations involved in airframe and engine repair and maintenance, avionics, systems, and components.

Overall, Singapore's indigenous presence in the aerospace sector is low, as multinationals account for 80 percent of the industry's total output.[650] Moreover, while the country's aerospace industry supports a total work force of 9,485, aircraft manufacturing activities accounted for less than 13 percent of the $1.2 billion produced by the aerospace industry in 1997.[651]

[646] Fong and Hill, "Government Policy," p. 246.
[647] Economic Development Board officials, interview by USITC staff, Singapore, May 12, 1998.
[648] Fong and Hill, "Government Policy," p. 248.
[649] Singapore Technologies Precision Engineering official, correspondence with USITC staff, July 17, 1998.
[650] Economic Development Board officials, interview by USITC staff, Singapore, May 12, 1998.
[651] Ibid.

Table 5-8
Singapore: Principal aerospace manufacturers and products

Company	Founded	Facilities	Staff	Annual sales (millions)	Products
Singapore Technologies Precision Engineering	1995	Aerospace:[1] Singapore Beijing, China Suzhou, China California, USA Medical Products: Singapore Germany Brazil USA Japan China India Australia	1500 -- total 550 -- aerospace	$250 (1997)	Aircraft parts: • Engine mounts for 777, MD-11, A310, A320, A330, A340 • MD-11 bulkhead, A320 passenger door, A340 thrust reverser upper door [2] • Maintenance access and accessory doors, bulkheads, and rib assemblies • Landing gear -- Raytheon 800 Series, A4 Skyhawk • Engine components, including blades, vanes, casings, seals and rings[3] Aircraft parts overhaul, repair, and support Medical equipment and services
Singapore Technologies Aerospace	1975	Singapore Alabama, USA Texas, USA London, U.K.	4,180 -- total	$421 (1997)	Repair, maintenance, and overhaul

[1] Aerospace manufacturing is carried out through STPE's four operating subsidiaries: Singapore Aerospace Manufacturing Pte Ltd. (Singapore); Beijing Casinda Precision Machinery & Electronics Co., Ltd., a joint venture between CATIC (51 percent) and Singapore Aerospace Manufacturing (49 percent); Singapore Tech Precision (Suzhou) Co. Ltd.; and California Avi-Tron Corporation.
[2] Beijing facilities manufacture the A320 passenger door, MD-11 bulkhead, and A340 thrust reverser upper door.
[3] Suzhou facilities manufacture HPC vanes and stud shoulders for the Pratt & Whitney PW4000 engine.

Source: Compiled from various sources by USITC staff.

Goals of Singapore's Aerospace Industry

Unlike China, Korea, and Indonesia, Singapore has no plans to lead a national aircraft program.[652] Instead, the country's Economic Development Board has focused its efforts on promoting Singapore's status as an aircraft service and supply hub in the Pacific region.[653] The country's manufacturing sector is committed to expanding production in value-added components and parts with wide application in the commercial aircraft sector, such as engine mounts, landing gear, actuators, and sheet metal assemblies.[654] At the same time, both government and industry want the aerospace sector to assume a greater role in product design and development and view participation in an aircraft program as a potential vehicle for the acquisition of such capabilities.[655]

[652] Ibid.; Singapore Technologies Aerospace official, interview by USITC staff, Singapore, May 13, 1998; and Michael Mecham, "Singapore Turns 'Linkages' into Business Asset," *Aviation Week & Space Technology*, June 3, 1996, p. 67.
[653] Economic Development Board officials, interview by USITC staff, Singapore, May 12, 1998.
[654] Ibid.; and Singapore Technologies Precision Engineering official, interview by USITC staff, Singapore, May 13, 1998.
[655] Singapore Government and industry officials, interview by USITC staff, Singapore, May 12-13, 1998.

Competitive Assessment

Availability of Capital

As a leading financial center in Asia, Singapore's well-developed banking infrastructure and stock and bond markets present companies with access to varied sources of capital. The number of large foreign aerospace entities involved in joint ventures and subsidiary enterprises in Singapore, including Daimler-Benz, Pratt & Whitney, and AlliedSignal, is indicative of support of the aviation industry by Singapore's financial community.

Both domestic and foreign companies also receive support from Singapore's government. The nation has undertaken a number of initiatives to develop the nation's technological capabilities in high value-added, state-of-the-art industries such as aerospace. Through a variety of tax incentives, including tax holidays and tax breaks for investment in specific technologies, Singapore seeks to attract investment by multinationals in aviation-related sectors.[656] In certain cases, the government provides start-up funds to companies or joint ventures in desired technological fields, then sells the state-owned portion of such businesses when the desired companies are established.[657]

Further, in addition to a number of national R&D support initiatives encompassing all high technology sectors, the National Science and Technology Board (NSTB), under the Ministry of Industry and Trade, directs R&D programs targeted at aerospace. For example, in 1996, NSTB launched the Aerospace Technology Program, 3-year project which provides $16 million in NSTB funds for R&D for qualifying aerospace projects.[658]

Industrial and Demographic Characteristics

Singapore's participation in the civil aircraft industry is limited by the nation's lack of natural resources and small domestic market. However, a highly skilled work force, technological capabilities, well-developed industry clusters, and advanced transportation and manufacturing facilities are competitive assets supporting Singapore's role as a player in the global aerospace industry.

Singapore's extensive military work and experience in subsystems upgrades have advanced the industry's design capabilities in areas such as avionics and electrical systems.[659] Though the industry has pursued these capabilities over structural design technologies, Singapore does participate in structural design programs. For example, the industry is designing the tail for Eurocopter's EC-120, and industry sources emphasize that Singapore has the technical base and

[656] Economic Development Board and U.S. industry officials, interviews by USITC staff, Singapore, May 12-13, 1998; and Mecham, "Singapore Turns 'Linkages' into Business Asset," p. 67.
[657] U.S. industry official, interview by USITC staff, Singapore, May 13, 1998.
[658] National Science and Technology Board official, interview by USITC staff, Singapore, May 12, 1998.
[659] Singapore Technologies Precision Engineering official, interview by USITC staff, Singapore, May 13, 1998.

inherent potential to build up core competencies.[660] In addition, though not as cost competitive as other Asian nations, labor costs in the aerospace sector are less than in the United States, and Singapore's work force is noted for quality production and schedule performance.[661] Further, the government provides training grants to build up the nation's skilled labor pool,[662] and the aerospace industry draws on outside academic resources to overcome the lack of a domestic aeronautical degree program. STPE, for example, has a scholarship program to educate staff at U.S., U.K., and French universities.[663] Similarly, government initiatives include foreign recruitment of research professionals in high technology fields such as aerospace.[664] In terms of research institutes, STAe maintains an engineering and development center and an R&D staff of 200, and NSTB supports two R&D centers, the Gintic Institute of Manufacturing Technology and the Institute of Material Research and Engineering, which contribute to the aerospace industry.[665]

Corporate and Program Characteristics

Singapore's government promotes a competitive business environment, and despite state involvement in the aerospace sector, Singapore's aviation companies function as commercial enterprises. As a result, the aircraft sector is able to reap the benefits of government support for investment, research, and training, while also benefitting from public disclosure and business decisions based largely on economic feasibility.

Singapore's aerospace sector has indicated that it does not wish to produce and market its own commercial aircraft. Therefore, factors concerning the market appeal of aircraft are not pertinent to the current activities of Singapore's aerospace industry. However, the country's experience in service and supply, reputation for competitive manufacturing, focus on profitability, and internationally recognized certification and quality standards are assets Singapore's aerospace firms could lend to a regional aircraft consortium. Moreover, the industry's participation in a joint venture or risk-sharing partnership could add credibility to a collaborative aircraft project. The aerospace sector has shown a willingness to take part in such projects with its involvement in the AE-31X regional jet and interest in future aircraft programs.

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[660] Singapore and U.S. industry officials, interviews by USITC staff, Singapore, May 13, 1998.

[661] U.S. industry official, interview by USITC staff, Singapore, May 13, 1998.

[662] Economic Development Board officials, interview by USITC staff, Singapore, May 12, 1998.

[663] Singapore Technologies Precision Engineering official, interview by USITC staff, Singapore, May 13, 1998.

[664] Economic Development Board officials, interview by USITC staff, Singapore, May 12, 1998. The EDB is also considering the implementation of joint degree and exchange programs with overseas universities, if necessary.

[665] Singapore Government and industry officials, interview by USITC staff, Singapore, May 12-13, 1998.

Arrangements with Foreign Aerospace Entities

Through cooperation with the United States and Europe via aviation-related joint-venture operations and foreign aerospace subsidiaries, Singapore's aircraft industry has gained capabilities in specialized manufacturing processes, particularly engine mounts and avionics, and the management of technologies.[666] Singapore's major collaborative projects, however, have failed to provide the aerospace industry with the transfer of new technologies, comprehensive understanding of manufacturing cycles, and industry spin-offs that the country hopes to gain through participation in cooperative ventures.[667] Moreover, industry representatives note that the nation's airline has not been particularly aggressive in using aircraft purchases to secure offset work and, subsequently, skills transfer for the country's aviation sector.[668]

Singapore was a partner in the canceled AE-31X regional aircraft program with AIA and Aviation Industries of China. Though Singapore's input was to be limited to subsystem integration work[669] and a role as liaison between the Chinese and European participants to facilitate the flow of the project,[670] termination of the AE-31X ended the industry's participation in an LCA program and precluded the opportunity for skills transfer to the aerospace sector. Likewise, while Singapore's 15-percent share of the EC-120 helicopter development program with Eurocopter[671] and CATIC (through Harbin Aircraft Manufacturing Corporation) provided the industry with a chance to design the EC-120 tailboom in cooperation with French designers, the bulk of engineering and manufacturing work is under the charge of the European and Chinese partners.

Rather than a recipient of technology transfer, Singapore has taken on an increasing role in overseas procurement, transferring work programs, materials, and know-how overseas to take advantage of lower labor costs. STPE, for example, maintains two factories in China that provide the company with engine parts and subassemblies for commercial aircraft.[672] Moreover, the company indicates that as domestic programs mature, additional work will be relocated to China.[673]

[666] Singapore Technologies Aerospace and Singapore Technologies Precision Engineering officials, interview by USITC staff, Singapore, May 13, 1998.

[667] Singapore Government officials, interview by USITC staff, Singapore, May 12, 1998.

[668] Singapore industry officials, interview by USITC staff, Singapore, May 13, 1998.

[669] Lewis, "Time Out in Asia," p. 39.

[670] Ibid., p. 40; and Charles Bickers, "Will It Fly?" *The Far Eastern Economic Review*, Nov. 21, 1996, p. 69.

[671] Eurocopter was formed through a merger of the helicopter divisions of Aérospatiale (France) and MBB. Eurocopter holds a 61-percent share in the EC-120 program, with CATIC accounting for the remaining 24 percent.

[672] Specifically, high pressure compressor (HPC) vanes and stud shoulders for the Pratt & Whitney PW4000 engine are produced in Suzhou, while the A320 passenger door, MD-11 bulkhead, and A340 thrust reverser upper door are manufactured in Beijing.

[673] Singapore Technologies Precision Engineering official, interview by USITC staff, Singapore, May 13, 1998. Singapore has already announced that after 10 shipsets it will transfer manufacture of the EC-120 tailboom to China and provide the Chinese factory with all the necessary tooling and program training to undertake production.

Japan

While Japan supports one of the area's more advanced aerospace manufacturing sectors, the nation's limited land area, past experience with commercial aircraft production, and focus on military products and international subcontracting work point to the unlikelihood of Japan's emergence as a competitor in the LCA industry. However, the aerospace sector's advanced technological capabilities, reputation for high-quality products, and relative financial strength are conducive to continued collaborative arrangements with global aerospace entities and a possible role as partner in an aircraft development program.

A ban on aircraft production during the U.S. occupation after World War II kept Japan out of the aerospace sector until 1952, at which time the country became involved in licensed production of military aircraft, followed by subcontracting work. Japan's attempts to take its innovative skills and subcontracting experience to the level of civil airframe competitor have been largely unsuccessful, evident in the country's YS-11 regional aircraft program and the numerous delays in Japan's plan to build a successor to the YS-11. The YS-11, a Japanese-designed 64-seat passenger turboprop developed in the 1960s, was deemed technically sound, but few orders materialized because of market demand for jet-powered aircraft and the lack of global product support. The program incurred huge losses, and at the close of production in 1973, only 182 aircraft had been produced.[674] The industry's successor program, the YS-X 100-seat regional transport, in development since the 1980s, has produced only feasibility studies and funding for the program was cut to $1.3 million for 1998-99,[675] presumably in response to a growing competitive environment in the medium-sized aircraft sector and the industry's lack of progress on the program. The country faces a number of additional obstacles to full-scale participation in aircraft manufacturing, including air transport infrastructure and regulatory constraints that limit the potential of the domestic market to support an aircraft program, reliance on the military sector,[676] relatively high costs, and national policies which prohibit the export of dual civilian and military use technology and products.[677]

The Japanese aircraft industry is characterized by a substantial number of linkages with foreign aerospace entities, including codevelopment arrangements, joint ventures, and coproduction and licensing agreements which provide the nation with technology transfer opportunities and civil aircraft manufacturing experience.[678] The strongest of these relationships is between Japanese manufacturers and Boeing, which has given the country subcontracting work for the 737, 747, 757, 767, and 777. Japan currently produces 15 percent of the 767, including the fuselage panels, fairings, main landing gear doors, and other components, and 20 percent of the 777, including the

[674] USDOC, ITA, National Trade Data Bank, "Japan--Civilian Aircraft," National Trade Data Bank, Stat-USA Database, found at Internet address http://www.stat-usa.gov, posted July 1, 1997, retrieved Oct. 28, 1997.

[675] Paul Lewis, "Asian Austerity Reigns," *Flight International*, Feb. 25-Mar. 3, 1998.

[676] The Japanese aircraft industry is highly dependent on the defense sector. Approximately 70 percent of the aircraft industry's output is defense related. Hiroshi Kubota, Machinery and Information Industry Bureau, MITI, "Japan: Japan's Aircraft Industry Current, Future," *Tokyo Kikai Shinko*, July 1997, FBIS translated text FBIS-EAS-97-322.

[677] David B. Friedman and Richard J. Samuels, "How to Succeed without Really Flying: The Japanese Aircraft Industry and Japan's Technology Ideology," ch. 7 in *Regionalism and Rivalry: Japan and the United States in Pacific Asia* (Chicago: University of Chicago Press, 1993), pp. 267-268; and USDOC, ITA, "Japan--Civilian Aircraft."

[678] Friedman and Samuels, "How to Succeed without Really Flying," pp. 274-275.

central section of the wing, fuselage panels, and doors.[679] Japan hoped that Boeing might be the Western partner to support its YS-X project,[680] but the company's decision to produce the 717-200 appears to preclude U.S.-Japanese cooperation on the similar YS-X program. The country's aerospace manufacturing industry, led by Mitsubishi Heavy Industries, Kawasaki Heavy Industries, Fuji Heavy Industries, and Shin Meiwa Kogyo Company, also produces engines, components, electronics, and avionics, and is involved in supersonic transport research.

Taiwan

Taiwan's aerospace industry has primarily served the domestic military sector through the licensed and indigenous production of fighters, trainers, helicopters, and components. However, in recent years, the industry has indicated a desire to become more heavily involved in commercial aerospace ventures and hopes to draw upon Taiwan's highly educated labor force, indigenous design capabilities, and experience in producing quality parts and avionics to modernize Taiwan's aerospace manufacturing base and expand joint-venture arrangements with other aircraft companies. Aerospace Industrial Development Corporation (AIDC), a state-owned enterprise that forms the core of Taiwan's aerospace industrial base, will become privatized in the next few years, freeing military aerospace technology for use in commercial applications.[681] AIDC has already become involved in international collaboration for the production of commercial components, including an agreement to build the empennage for Boeing's 717-200, and has plans to jointly manufacture engines and parts for the Sikorsky S-92 helicopter.[682]

In the longer term, Taiwan's aerospace sector will focus on further development of design and innovation skills and seek an extended customer base for Taiwan-manufactured parts and subassemblies. Taiwan also wants to participate in the design and manufacture of commercial aircraft and has concluded introductory collaborative arrangements with foreign producers. Under the U.S.-Taiwan joint venture Sino-Swearingen, the aerospace sector is producing major parts and components for the SJ-30, a six-seat business jet, and the industry is involved in the joint development of the Ae-270 utility turboprop in cooperation with the Czech Republic.[683]

The Taiwanese aerospace sector supports 11,500 employees and produced over $20 million in military and commercial aircraft parts and components in 1996.[684] In addition to nearly 170 private and public organizations, Taiwan's aerospace industry includes 24 companies certified by foreign aerospace companies for the manufacture and repair of parts and 4 main facilities for R&D. Two of these organizations, the Committee for Aviation and Space Industry Development and the Center for Aviation & Space Technology, promote technology transfer between private,

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[679] USDOC, ITA, "Japan--Civilian Aircraft;" and Paul Lewis, "Japan Seeks Funds for 747X Development Work," *Flight International*, Sept. 25-Oct. 1, 1997, p. 11.

[680] Paul Lewis, "Difficult Journey," *Flight International*, Sept. 4, 1996, p. 61.

[681] USDOC, ITA, National Trade Data Bank, "Taiwan--Commercial Aerospace Industry," Stat-USA Database, found at Internet address http://www.stat-usa.gov/, posted Aug. 10, 1997, retrieved Oct. 28, 1997.

[682] Ibid.

[683] Ibid.; and "Sino-Czech T-prop to be a 50/50 Split," *Aviation International News*, Aug. 1, 1997, p. 60.

[684] USDOC, ITA, National Trade Data Bank, "Taiwan--Commercial Aerospace Industry."

military, and foreign enterprises, with a combined annual R&D budget of approximately $6 million.[685]

Summary

Due to the lack of both technological experience and sufficient international and regional cooperation, it appears unlikely that Asian nations can directly compete against U.S. and European manufacturers in the LCA market during the next 15-20 years. China's immediate future is in partnerships with Western and Asian nations and an increased role as subcontractor of parts, components, and subassemblies for LCA and engines. The Chinese industry's lack of basic technological competencies and lingering difficulties with quality, schedule, and systems coordination make it improbable that the aviation community will be able to initiate an independent aircraft program for several years. While restructuring may increase the effectiveness and competitive focus of the aircraft manufacturing sector, industry sources predict that it will take China 20-25 years to become capable of constructing a comprehensive indigenous aircraft program.[686]

Korea and Indonesia, both significantly affected by the Asian financial crisis, face severe capital constraints which will delay the development of each country's aerospace sector and a realization of their specified goals. Restructuring of Korea's industrial sector may result in a more competitive industry capable of using its skills in research, production, and marketing in a more efficient and focused manner. However, in terms of the regional aircraft program, the industry's desired collaborative arrangement with foreign partners remains elusive. In addition, though Indonesia may be able to resurrect its jet aircraft program through fund-raising schemes or risk-sharing partnerships, questions of reliability and after-sales support could confine the Indonesian regional jet to developing country markets. Moreover, without a foundation of basic technologies, a developed supplier base for parts and raw materials, and the continuation of guaranteed government support, the sustained existence of IPTN remains doubtful.

Singapore, Japan, and Taiwan, bound by physical space, smaller markets, and distinct production capabilities, will presumably play the role of partner in any aircraft program. Singapore's focus on profitable ventures and specific aerospace sectors point to the improbability of Singapore assuming other than a supporting role in a regional jet program. Similarly, Japan, having failed in its indigenous aircraft program and with recent economic difficulties of its own, is reportedly satisfied to serve as a key supplier to U.S. industry.[687] Taiwan, a relative newcomer in commercial aviation, presently lacks the experience and infrastructure necessary for large-scale participation in the LCA industry.

Asian collaboration could draw together many of the necessary elements of an aircraft production and development program. However, political and historical considerations render an Asian aircraft consortium difficult. For example, historic events impede cooperation between Japan and China or Korea, and political differences reportedly prevented Taiwan's participation in the former AE-31X regional jet program. Indonesia indicates that because of the nation's historical

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[685] Ibid.

[686] European industry officials, interview by USITC staff, Paris, France, Apr. 2, 1998.

[687] Asian and U.S. industry officials, interviews by USITC staff, Asia, Apr. 29-May 4, 1998, and Seattle, WA, Feb. 11, 1998.

anticommunist stance it cannot cooperate with China,[688] and Korean industry sources intimate that a second try at collaboration between Korea and China is improbable.[689] Further, if Asian nations, independently or in collaboration, are able to accumulate the resources necessary for production of a globally competitive aircraft, the development of a family of aircraft, which would allow competition on a parallel basis with Western LCA manufacturers, is unlikely to be achieved without decades of experience and massive infusions of capital.

Implications for the Competitiveness of the U.S. LCA Industry

While it appears that an imminent Asian competitor in the LCA industry is unlikely, Asian nations' desire to acquire advanced aircraft manufacturing capabilities could affect the U.S. industry as airframers are drawn into licensed production, subcontracting, codesign, and joint-development contracts via offsets tied to LCA sales. Both U.S. and West European producers cite market access as a key factor in overseas subcontracting;[690] thus, countries with strong potential demand for aircraft are in a favorable position to solicit work packages, instruction in processes and basic technology, and joint-development arrangements. Moreover, once an LCA producer becomes established in a particular country, sustained procurement is probable due to the large initial investment required and the manufacturer's desire to maintain long-term working relations with the host country. For example, Boeing's long history of cooperation with China and Japan is certain to be maintained in order to fully utilize the resources and infrastructure cultivated by Boeing and decrease the likelihood of lost market share to outside producers willing to offer similar production arrangements. Similarly, as new markets open up or existing markets expand, market access concerns are likely to prompt greater collaboration with Asian countries and a deepening of existing manufacturer-supplier relationships.

The implications of such arrangements are threefold. In the short run, establishing a supplier base in countries where a foundation for aircraft production is absent or underdeveloped entails a great deal of capital which can add to the overall costs of the manufacturer. Both U.S. and West European producers confirm the considerable costs involved in setting up production infrastructure, training foreign management and production workers, and maintaining in-country staff for technical assistance and oversight.[691]

Second, Asian nations' participation in the aircraft sector and their push to acquire advanced aerospace knowledge could lead to a transfer of technology to potential competitors. To date, U.S. producers indicate that they have only provided Asian aircraft factories with process manufacturing skills and dated technologies.[692] However, as some Asian sources note that West

[688] Indonesian Government officials, interview by USITC staff, Jakarta, Indonesia, May 14, 1998.
[689] Korean industry officials, interviews by USITC staff, Pusan and Seoul, Korea, Apr. 29 and May 1, 1998.
[690] U.S. and European industry officials, interviews by USITC staff, Seattle, WA, Feb. 10, 1998, and Toulouse, France, Apr. 6-7, 1998.
[691] U.S. and European industry officials, interviews by USITC staff, Seattle, WA, Feb. 10, 1998, and Toulouse, France, April 8, 1998.
[692] U.S. industry officials, interview by USITC staff, Seattle, WA, Feb. 10, 1998.

European competitors dispense key technologies more freely,[693] U.S. LCA manufacturers could find it increasingly difficult to balance the desire for market access with the need to retain critical technologies.

Finally, in the long term, when technical processes and a manufacturing foundation are firmly in place, the U.S. industry can enjoy a period of reduced costs due to Asian nations' comparatively cheap labor, combined with decreased expenditures on capital inputs and oversight. Moreover, U.S. airframers can benefit from added financial input from Asian producers in risk-sharing arrangements, which could also decrease the overall costs incurred by U.S. industry, particularly with respect to new programs.

The desire of Asian nations to gain subcontracting experience and key technologies may provide a further challenge to U.S. suppliers of parts, components, and subassemblies. As Asian nations build upon the foundation laid by Western contractors and progress from the fabrication of low-level components to more complex and technologically demanding parts and subassemblies, the Asian supply sector may emerge as a competitive challenge to U.S. manufacturers of like products. U.S. manufacturers will then be faced with the need to forge ahead with new technologies to stay one step ahead of potential Asian competitors, employ greater cost-efficient production processes, locate work overseas, or vertically integrate their manufacturing base. At the same time, in the event that Asian nations are able to produce a competitive aircraft for the global market, for purposes of efficiency and commonality with existing aircraft, it is unlikely that Asian manufacturers will produce all the necessary components. As is the case with the Indonesian N-250, which relies primarily on imported components, and the latest Chinese-built Y-12 IVs, which will source avionics, wheels, brakes, and interior components from North American suppliers,[694] Asian-made aircraft could provide increased opportunities to U.S. suppliers of aircraft parts, assemblies, and subsystems.

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[693] Asian industry officials, interview by USITC staff, Korea, May 1, 1998, and Singapore, May 13, 1998.

[694] With respect to the Y-12 IV aircraft delivered to the Canadian Aerospace Group, 65 percent of the aircraft's content will be sourced in Canada. "CAG Secures its First Order for Y-12 Twin Panda," *Flight International*, June 24-30, 1998, p. 11.

CHAPTER 6
CHANGES IN THE STRUCTURE OF THE MARKET FOR LARGE CIVIL AIRCRAFT

Overview

Increased price competition and resulting cost pressures within the airline industry, coupled with ongoing changes in the transportation regulatory environment, are encouraging the development of new classes of aircraft at the upper and lower ends of the large civil aircraft product range. These new programs will add segments in which global LCA producers compete and may affect the relative competitive standing of the U.S. LCA industry in the global market.[695] This chapter describes important airline industry factors that contribute to structural changes in the global market for LCA, particularly those leading to the development of the 100-seat and 500-seat aircraft programs. The likely effects of these new programs on suppliers, airlines, and U.S. and foreign aircraft producers are also discussed. Finally, the possible effects of regulatory influences on the LCA market, including the bilateral agreements that govern international traffic and developments in the air traffic control system, are assessed.

The Market for New Commercial Aircraft Programs

Airlines face a competing set of interests when developing their market strategies--to increase service frequency and direct routing while keeping ticket prices low--and LCA manufacturers are responding to these divergent needs with two new classes of aircraft. The first of these new LCA is a relatively small airliner designed specifically for the 100-seat market, and the second is an ultra-high capacity (500- to 1,000-seat) airliner. These aircraft will broaden the optimal range-capacity combinations of aircraft beyond those currently produced by LCA manufacturers and may have a significant impact on the mix of products used by airlines.

Changing airline service factors form the basis of demand for different types of aircraft, and thus for the emergence of new LCA programs. For example, increased price competition among airlines, triggered by the deregulation of the airline industry,[696] promoted the development of “hub and spoke” route networks,[697] which in turn changed the composition of the airline fleets used to service those routes. As a result of price competition, airlines have increasingly pressured aircraft manufacturers to raise the operating efficiencies of aircraft, resulting in expansion of the aircraft

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[695] The changing competitive position will be affected mainly by the improved market appeal of the entire Airbus product line, if its 500-seat program can be brought to market.

[696] Steven A. Morrison and Clifford Winston, *The Evolution of the Airline Industry* (Washington, DC: The Brookings Institution, 1995), p. 11.

[697] Hub-and-spoke networks are composed of shorter flights feeding into hub airports. Airlines with this type of route structure may employ more, and smaller, aircraft than they would otherwise.

market.[698] In addition to intense competition based on lower prices, airlines are also currently attempting to differentiate service based on other convenience factors such as increased flight frequencies and the availability of direct flights.[699] Further changes of airline route structures are likely to result as airlines accommodate the substantial increases in passenger demand expected in both established and new markets.[700]

Although airlines often use adaptations of currently available aircraft to meet their changing needs, entirely new aircraft must be developed periodically to fully address airline requirements. Most new aircraft introduced to satisfy changing airline preferences are derivatives, or modified versions of previously introduced aircraft types, redesigned to expand the product offering of a manufacturer with respect to specific combinations of passenger capacity, range, physical characteristics, and operating economics. Completely new types of aircraft are developed only when derivatives of currently produced versions are infeasible, and the expected financial return on a previously untapped market is large enough to warrant the substantial, nonrecoverable investment required of new product development.[701] The expected growth in airline passenger demand, combined with evolving factors of airline competition, improves the market prospects of new purpose-built[702] 100- and 500-seat products being developed.

Demand projections for 100-seat jet aircraft are partially based on replacing smaller capacity regional aircraft that are inadequate to satisfy the expected growth in passenger demand on high-frequency or developing routes. Though smaller aircraft allow airlines to offer increased flight frequency and more direct service, these aircraft are generally more expensive to operate per seat-mile when compared to larger LCA.[703] Moreover, adding flights to increase convenience and satisfy growing demand is partially constrained by increasing levels of congestion at high-volume airports.

Demand for 500-seat airliners is based on expected growth in passenger demand on certain high-volume routes that cannot be satisfied by increasing the number of flights. This applies

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[698] Increased operating efficiencies of new aircraft have been estimated to contribute roughly one-third of the productivity gains within the airline industry. Badi H. Baltagi, James Griffin, and Daniel Rich, "Airline Deregulation: The Cost Pieces of the Puzzle," *International Economic Review*, vol. 36, Feb. 1995, pp. 245-58.

[699] Other convenience factors include on-time departure and arrival, ease of ticketing and check-in, and frequent flyer programs. Morrison and Winston, *The Evolution of the Airline Industry*; and Atef Ghobrial and Soliman Y. Soliman, "An Assessment of Some Factors Influencing the Competitive Strategies of Airlines in Domestic Markets," *International Journal of Transport Economics*, vol. XIX, No. 3, Oct. 1992, pp. 247-58.

[700] Airbus projections estimate world airline traffic growth at 5.3 percent per year through 2007 and 4.8 percent through 2017. Airbus Industrie, *Global Market Forecast, 1998-2018* (Blagnac, France: Apr. 1998), p. 21. Similarly, Boeing projects passenger traffic growth at an average of 4.9 percent per year through 2017. Both Boeing and Airbus expect much of this growth to occur in emerging markets for air travel. Boeing Commercial Airplane Group Marketing, *1998 Current Market Outlook* (Seattle, WA: June 1998), pp. 9 and 23.

[701] European aerospace industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[702] Purpose-built aircraft are those which are optimized for a specific passenger capacity and/or airline market.

[703] Boeing officials, interview by USITC staff, Seattle, WA, Feb. 10-12, 1998; and European industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

particularly to routes connecting airports with continually increasing capacity constraints, and long-distance routes for which the acceptable corresponding takeoff and landing windows are limited or restricted by practical and environmental concerns.[704] Moreover, since larger aircraft are less costly per seat-mile to operate than smaller aircraft, they may reinforce the trend toward increased fare competition among airlines.[705]

Market for New Commercial Aircraft with 100-Seat Capacities

Definition of the Market and Product

The market for 100-seat aircraft is generally defined as the market for commercial aircraft with accommodations for 70-120 passengers.[706] These aircraft are typically suited for short- to medium-range, high-frequency routes. This is not an entirely new type of aircraft, as the first short- to medium-range jet aircraft produced in the early- to mid-1960s in the United States had 100-seat configurations.[707] With the subsequent growth in demand for jet air transportation, new short- to medium-range aircraft were designed with larger seating capacities and older models were replaced with versions that generally expanded seating and range capabilities.

The average size of aircraft in the U.S. commercial airline fleet, as measured by seating capacity, has continued to grow over the last 18 years, but slowed after airline deregulation as a result of the development of hub-and-spoke systems and the entry of short-haul, regional carriers.[708] New product development within the 100-seater market highlights the importance of short-haul aircraft, and is expected to be important to airlines wishing to: 1) replace their current, smaller aircraft; 2) provide increased flight frequency on existing routes; and 3) expand their route structure into new, but growing markets.

[704] Practical concerns include takeoff and landing times that are both within acceptable hours (e.g., neither is at 4:00 a.m.); environmental concerns include the closure or reduction of operations during certain hours because of noise considerations. Boeing officials, interview by USITC staff, Seattle, WA, Feb. 10-12, 1998; and European industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[705] Boeing, *1998 Current Market Outlook*, p. 30.

[706] Compiled from responses to USITC airline questionnaires, Feb. 1998.

[707] Examples include Boeing's 727-100 (94 seats) and McDonnell Douglas's DC-9 Series 10 (80 seats). The Boeing 727-100 and the DC-9-10 had ranges of over 1,100 nautical miles (with 18,000-29,000 pounds of payload). John W.R. Taylor, ed., *Jane's All the World's Aircraft, 1974-75* (London: Jane's Yearbooks, 1975).

[708] The average number of seats per aircraft in the U.S. commercial airline fleet increased by 20 during 1978-83. Excluding new small regional carriers, the average number of seats per aircraft increased by only 6.9 during 1983-96. Including the small regional carriers, average seating capacities actually fell by 4.5 seats. Federal Aviation Administration, *FAA Aviation Forecasts: Fiscal Years 1997-2008* (Washington, DC: FAA, 1997), p. III-29.

The new 100-seat aircraft lies between aircraft models generally associated with the LCA industry and the smaller models used by regional airlines.[709] One of the most important factors contributing to the historical distinction between regional and LCA models were the "scope clauses" found in major airlines' labor contracts. These clauses continue to preclude pilots of regional aircraft for major airlines' subsidiaries from flying aircraft with more than 70 seats (without being compensated at rates commensurate with the higher wages paid to pilots flying larger LCA aircraft), and effectively provide an upper limit on the size of aircraft that can be used by the regional carriers. Because scope clauses limit most airlines' ability to operate aircraft models both above and below the 70-seat threshold, advantages associated with a family of aircraft between 50-100 seats are also limited.

A number of factors have contributed to an easing of scope clause limitations. In response to competition from low-cost and regional carriers, major airlines have started or expanded the use of subsidiary or affiliated carriers. This has allowed major carriers to expand their feeder networks while reducing costs to better compete with low-cost and independent regional carriers.[710] As demand for such service has grown, the size of aircraft used has increased, pushing against the capacity barriers of the scope clauses. Aircraft manufacturers are responding by attempting to provide a family of aircraft that spans the 70-seat range. The market segment these changes have exposed is referred to as the 100-seat market. As a result, the distinction between the products of LCA manufacturers and of regional aircraft manufacturers is becoming less obvious.

Analysis of the Market

To correctly characterize the 100-seat market, it is important to determine the types of aircraft that airlines consider for this segment, i.e., which aircraft the 100-seat aircraft will compete against for market share. Since the new 100-seat airliners are larger than aircraft traditionally used by regional airlines and small relative to aircraft used by major commercial airlines, it is not readily apparent to which market segment this type of airliner belongs.[711] Therefore, the following analysis of the narrow-bodied aircraft market considers whether the 100-seat aircraft is best described as: 1) indistinguishable from the general LCA market; 2) part of a newly emerging 70- to 120-seat market segment; or 3) part of a mature aircraft market.[712] To group aircraft belonging to each segment, the degree of product differentiation in the narrow-bodied aircraft market is

[709] Regional aircraft are also generally associated with turboprops whereas LCA are typically powered by turbofan engines. However, this distinction is increasingly outdated as regional airlines have moved toward slightly larger aircraft powered by turbofan engines, a change partly due to passenger preferences for jet, rather than turboprop aircraft. Turboprop avoidance is discussed in Ghobrial and Soliman.

[710] Though scope clauses continue within the industry, large commercial airlines are using 100-seat aircraft to compete with emerging low-cost carriers because pilot wages are somewhat lower for smaller aircraft. Boeing officials, interviews by USITC staff, Seattle, WA, Feb. 10-12, 1998.

[711] Industry sources also indicated difficulty in categorizing the newly proposed 100-seat aircraft, and were therefore unable to provide a clear answer to the question about market segmentation. European aerospace industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[712] A complete description of the analysis and methodology associated with the 100-seat market definition is contained in Appendix H.

identified by focusing on specific product characteristics of aircraft models[713] and comparing them to a set of characteristics that might be required by airlines wishing to purchase new aircraft. After analyzing a large number of product characteristics typical of narrow-bodied aircraft, the results of the analysis suggest that two dominant characteristics--capacity and range--appear to be sufficient to group airliners.

Because larger commercial airlines traditionally operate only larger jet aircraft, including a number of models in or near the upper range of the 100-seat market,[714] it may seem logical to consider the 100-seat aircraft as the smallest unit in the LCA industry. However, because each LCA airframe currently being produced with less than 125 seats is a smaller version of an aircraft designed to carry a larger passenger load,[715] such shortened LCA cost more to operate than aircraft optimized for the 100-seat range. Another argument against categorizing 100-seat aircraft as part of the LCA market is that manufacturers producing aircraft for this segment have been largely regional aircraft makers.[716]

Results of the analysis indicate that proposed new 100-seat programs are best described as a separate niche in the market for airliners. Based on the market segmentation analysis, the narrow-bodied jet aircraft market appears to have at least a three-tiered structure, including a market segment for aircraft with less than 70 seats, the newer "100-seat" segment encompassing narrow-bodied aircraft with 70-120 seats, and the segment consisting of remaining narrow-bodied LCA. Further supporting the idea of a separate market segment, all current manufacturers of turbofan aircraft either produce aircraft that are all larger or all smaller than 70 seats. To date, commercial models produced by Boeing, Airbus, the former McDonnell Douglas, and British Aerospace Regional Aircraft/AVRO are configured with 70 or more seats, whereas Bombardier, EMBRAER, and Fairchild-Dornier produce models that all have fewer than 70 seats.[717] Moreover, where the new 100-seat aircraft were found to be most similar to in-service regional and LCA aircraft models, those regional and LCA models are generally no longer produced.[718]

Factors Affecting Projected Demand

Demand for 100-seat aircraft is driven by several factors, including the replacement of aircraft in the existing global fleet, a broadening of the air transport market, and shifts in the airline industry route structure toward increased frequency and direct routing. According to industry sources, only now have these factors of demand formed a base large enough to support the launch and

[713] Specifically, this encompasses all available turbofan/jet narrow-bodied aircraft with seating capacities above 32 passengers, and a select number of newly-proposed like aircraft.

[714] These include the Boeing 737-500 (108 seats), Boeing 737-200 (115 seats), Boeing 737-300 (128 seats), Airbus A319-100 (124 seats), and McDonnell Douglas MD-87 (109 seats), and DC-9-40 and -50 (132 seats). Only the 737-500, 737-300, and A319-100 remain in production. Paul Jackson, ed., *Jane's All the World's Aircraft* (Surrey, UK: Jane's Information Group Limited, various years).

[715] Jackson, ed., *Jane's All the World's Aircraft, 1996-97*, various pages.

[716] Examples of such producer's models include British Aerospace's AVRO products (70-128 seats), and Fokker's F-28, and F-70 and F-100 (70-100 seats).

[717] Fokker was the only manufacturer producing turbofan aircraft that spanned the 70-seat threshold, but the company is in bankruptcy and is currently being liquidated. NB: No causality can be inferred between Fokker's bankruptcy and the fact that it was the only aircraft producer with a product line that spanned the 70-seat range.

[718] One such example is the Fokker 100.

production of newly designed 100-seat aircraft models,[719] where profit margins are typically small. The combined effect from multiple demand sources may allow sufficient production for manufacturers to take advantage of increasing returns to scale in the manufacturing process.

The first important factor in this market is demand derived from the replacement of older aircraft, still in operation, that fall within the 100-seat market.[720] Sixteen older aircraft models with capacities of 70-124 seats are a part of world airline fleets, accounting for 2,217 aircraft in 1997.[721] Although new 100-seat programs will initially face price competition from such older models in the used aircraft market, over the long term, new programs will enjoy reasonable levels of demand resulting from the replacement of these older aircraft.[722] The decision to replace is largely influenced by operating costs but is also affected by important changes in the regulatory environment, such as the requirement to modernize older, Stage 2 aircraft to meet more stringent noise pollution standards. To satisfy these standards, airlines may either purchase new Stage 3-compliant aircraft or install noise reduction kits or new engines on existing aircraft. Many of the 100-seat aircraft models in service fail to satisfy current Stage 3 noise pollution standards;[723] therefore, the replacement decision will be contingent on both price and operating costs of newly produced aircraft as well as the costs of modifying older airplanes.[724]

Second, income and population growth in smaller or emerging markets will increase demand for service in those markets, generally leading to the replacement of small regional aircraft by larger aircraft. Likewise, income growth in developing countries may provide a substantial market for 100-seat aircraft if those markets mature in a pattern similar to those in developed countries, which generally started with smaller capacity aircraft and moved up to larger airframes as the market expanded.

Third, if airlines increasingly compete on the basis of convenience, the smaller 100-seat aircraft will become more important in establishing airline route structures that accommodate greater frequency of service and direct routing. The improved efficiency of new purpose-built 100-seat aircraft designs (relative to those that are smaller versions of larger aircraft) will also permit LCA manufacturers to broaden their product offerings to airlines wishing to efficiently optimize their aircraft fleets to provide lower-cost, higher-frequency service.[725] Finally, the proposed designs of the 100-seat aircraft open the possibility of profitable service to new city-pairs. It is difficult to predict the emergence of new economic activity where none was previously present, but new

[719] European aerospace industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[720] These aircraft will replace the DC-9, MD-80 through -87, Boeing 727-100 and 737-100, Fokker F28, and the early BAe-146 models.

[721] Jet Information Services, *World Jet Inventory: Year-End 1997*; and *World Jet Inventory: Year-End 1995* (Woodinville, WA: Jet Information Services, Inc., 1998 and 1996).

[722] This result also is projected in all manufacturer market analyses.

[723] Derived from data available from Jet Information, *World Jet Inventory: Year-End 1997.*

[724] Airbus Industrie North America, interview by USITC staff, Herndon, VA, Oct. 23, 1997.

[725] The new 100-seat aircraft may overlap the current offerings of Boeing and Airbus at the 120-seat size, which could affect the timing of the final versions that are manufactured. It also remains to be seen whether the new aircraft in this market will have commonality with current LCA products. If so, these aircraft will be more easily categorized as LCA.

service is possible both because of airline entry spurred by lower-cost turbofan aircraft,[726] and because new models designed for short-range, high-frequency route structures will facilitate more direct routing of flights.

In its annual analysis of global demand for aircraft, Airbus projects a demand for at least 2,124 aircraft in the 70- to 100-seat range,[727] accounting for 12 percent of the total market for LCA during 1998-2017.[728] Boeing partitions the market for smaller turbofan aircraft into two groups--aircraft in the 50- to 90-seat range and those with 91-120 seats; during 1998-2017, deliveries are forecast at 1,578 and 2,127 aircraft, respectively,[729] for a combined market share of just over 21 percent. The primary obstacles to these positive demand prospects for the 100-seat aircraft are the cost of the newer aircraft and availability of financing to airlines. Because of the availability of used aircraft modified to satisfy the more stringent noise pollution standards, new aircraft will have to be competitively priced and offer significant operating cost advantages to gain widespread acceptance. Moreover, the production cost of a 100-seat aircraft remains problematic for all manufacturers, because systems are similar to and generally as expensive as those on larger aircraft, but the 100-seat aircraft must have a lower purchase price than larger aircraft to be competitive.

Producers and Potential Producers of New 100-Seat Aircraft

Because of the interest of a number of producers in developing new aircraft to address this market segment, competition likely will be stronger than in most other segments, and is likely to place producers of LCA in direct competition with several regional aircraft manufacturers also developing aircraft of this size. Entrants and potential entrants into the 100-seat market include the traditional Western LCA manufacturers,[730] aircraft manufacturers that currently produce regional jet transport aircraft, and producers based in several countries whose governments have shown an interest in promoting the manufacture of aircraft.

In the 100-seat market, Boeing will gain first-mover advantages with the 717-200 aircraft acquired from McDonnell-Douglas; nevertheless, Airbus will likely enter this niche with a shortened version

[726] Such was the case in the early 1990s with AirTran and Kiwi Airlines, two companies that were able to enter the market because of the availability of relatively inexpensive, previously-owned aircraft.

[727] The forecast demand for 2,124 (1,649 new) 70- to 100-seaters does not represent the total demand for aircraft in these size categories, because demand from smaller airlines and current turboprop operators is not included in the *Global Market Forecast*. Airbus, *Global Market Forecast*, 1998-2018 (Blagnac, France: Airbus Industrie, Apr. 1998), p. 41.

[728] By dollar value, purchases of aircraft in this category represent just 3 percent of the total business volume. Airbus, *Global Market Forecast, 1998-2018* (Blagnac, France: Airbus Industrie, Apr. 1998), p. 45.

[729] Boeing Commercial Airplane Group, *1998 Current Market Outlook* (Seattle, WA: June 1998), p. 49.

[730] Currently, established manufacturers participate in this market with variants of aircraft optimized at a higher seat capacity. For example, Boeing manufactures the 737-500 and -600, which are available with 108 seats, but were not originally optimized for this market. This also applies to Airbus's A319 (124 seats), which is a shortened version of the 150-seat A320.

of an existing model, the A318.[731] The purpose-built 717-200 is likely to provide airlines with significant operating cost advantages over a derivative, but the Airbus model is likely to offer greater commonality with other Airbus models than the 717-200 will have with the Boeing fleet. Boeing has targeted the plane for the regional jet market.[732] The Boeing 717-200 will typically seat 106 passengers in a two-class configuration, or 117 passengers in a single-class configuration. To increase the aircraft's market appeal, modifications on this basic design will allow it to seat 70-130 passengers.[733] Another producer, British Aerospace, has manufactured turbofan regional aircraft since 1983 under both its BAe and AVRO names. It currently produces aircraft seating 70 to 128 passengers. Through 1997, BAe has delivered 317 regional jets.[734]

Airbus was strongly pursuing this market with development of the AE-31X in a consortium involving Airbus Industries Asia, Aviation Industries of China, and Singapore Technologies Pte Ltd.[735] The consortium was expected to represent an important player in the 100-seat market, as significant Chinese involvement was likely to have influenced Chinese airlines to select this aircraft over potential alternatives to supply their large domestic market. However, questions regarding production arrangements were not resolved satisfactorily, and the program was canceled in July 1998. The cancellation of the AE-31X 100-seat program may result in increased market potential for other emerging 100-seat producers.

Russian producer Tupolev has also been developing a 100-seat aircraft,[736] the Tu-334, in 72- to 126-seat configurations, but as a result of undercapitalization, the aircraft's first flight has been considerably delayed. Tupolev has yet to produce an aircraft certificated for the Western market. Once certificated by Western airworthiness authorities, Tupolev will require significant additional resources to gain widespread acceptance of the Tu-334, including a reliable global service and parts network as well as a level of capitalization necessary to assure aircraft purchasers of the long-term viability of the manufacturer.[737]

Smaller, regional aircraft manufacturers that have considered 100-seater programs include Bombardier (Canada) and EMBRAER (Brazil). Each company currently builds a 50-seat turbofan aircraft.[738] In January 1997, Bombardier announced the launch of the 70-seat Canadair Regional Jet Series 700, which is an expanded version of its 50-seat aircraft. Mitsubishi (Japan)

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[731] The A318 will be a shortened version of the A319, which is itself a shortened version of the A320.

[732] According to Boeing, this market demands full-size jetliner comfort, low operating costs, high schedule reliability, efficient short-hop service, short-field operations, fast turnaround at airport gates, and the ability to sustain numerous flights daily. Found at Internet address http://www.Boeing.com/commercial/717/index.html, retrieved July 6, 1998.

[733] "MD-95 Re-emerges as Boeing 717," *Flight International*, Jan. 14-20, 1998, p. 4.

[734] Jet Information, *World Jet Inventory: Year-End 1997*, p. 14.

[735] This consortium is described more fully in Chapters 3 and 5.

[736] See Chapter 4 for a further discussion of Tupolev's product line.

[737] European aerospace industry officials, interviews by USITC staff, London, Brussels, Bonn, and Paris, Mar. 30-Apr. 3, 1998.

[738] EMBRAER has chosen not to compete immediately in the 70-seat market, announcing in September 1997 that it will produce a 37-seat aircraft instead. This decision is partly based on the constraint that EMBRAER cannot use the current 50-seat aircraft's fuselage or wing on a 70-seat airplane. Consequently, the design will require an all-new aircraft, significantly raising the price of entry into this market. EMBRAER is currently engaged in discussions with Korean and Swedish firms as it seeks risk-sharing partners for the larger aircraft.

has also had discussions with Canadair about the use of Canadair's newly designed wing on a family of 100-seat aircraft.[739]

Fairchild-Dornier is developing a new 32- to 34-seat turbofan aircraft, the 328JET, and has announced two additional regional jet programs; one involves stretching the current 328JET from 32 seats to 42 seats and the second (already launched) will introduce three new aircraft: a 55-seater, a 70- to 75-seater, and a 90-seat model.[740] These programs will be developed in a joint arrangement with risk-sharing partners.[741] Other companies considering a regional jet (or participation in a program) include PT Industri Pesawat Terbang Nusantara (IPTN) (Indonesia) and Saab (Sweden). Indonesia has indicated its desire to bring to market the IPTN-designed N-2130 turbofan, a 104- to 132-seat aircraft that began as an outgrowth of its N-250 turboprop.[742] Although Saab announced it will cease production of its new Saab 2000 turboprop aircraft, it has discussed the possibility of partnering with other aircraft manufacturers to produce regional jet aircraft.[743]

Effect on the LCA Industry

The results of the analysis indicate that the new 100-seat programs proposed by Boeing and Airbus represent expansion into market areas that could position existing LCA manufacturers against a new group of competitors. The entry of broad-based LCA manufacturers into this product niche may significantly affect the competitiveness of existing regional aircraft manufacturers serving this market, and heightened competition may also make it more difficult for new producers to succeed. Based on their superior resources, Boeing and Airbus could establish control of this market. However, newer entrants into this market that arise from the ranks of regional jet manufacturers may have some advantage based on their knowledge of the market and prior experience building similar smaller aircraft.

Market for LCA with 500-Seat or Greater Capacities

Definition of the Market and Product

Both Boeing and Airbus are actively investigating the prospects for an emerging market for ultra-high capacity aircraft. This new aircraft has been variously named the ultra-high capacity aircraft, the new large aircraft, and the very large aircraft. The unique combination of characteristics of this new type of airplane defines this particular market segment. Expected to operate on routes currently being serviced by the largest existing aircraft, the new aircraft will have passenger

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[739] This wing is currently incorporated on its Global Express business jets.

[740] Gregory Polek, "Fairchild Dornier launches new jets," *Aviation International News*, June 1, 1998, pp. 1, 42.

[741] Ibid.

[742] The recent macroeconomic crisis in Indonesia will likely delay development for a number of years. See Chapter 5 for a further discussion of the Indonesian aerospace industry.

[743] Although Saab will cease production of smaller regional aircraft in mid-1999, product support will be continued. Found at Internet address http://www.aerokurier.rotor.com/akNachr/AKNACHF/AenVere.htm, retrieved on July 6, 1998.

capacities beyond any currently available. Therefore, it is being designed for city-pairs with extremely high passenger volumes and/or limited possibilities for increased flight frequencies. A second important characteristic of the new 500-seat aircraft is the lower cost per seat-mile generally associated with larger aircraft. To date, potential aircraft models that might enter this market segment remain in the research and design stages.

Factors Affecting Projected Demand

Because of the aircraft's size and the over-$200 million projected purchase price, the number of delivered 500-seat aircraft is expected to be relatively small.[744] This aircraft will initially address only very high volume routes in which one or both airports on the route are experiencing congestion, roughly 30-90 city-pairs, a demand base substantially smaller than any other segment of the market. Since there are few alternatives to long-distance, high-speed air travel, the continued growth of passenger air service and increasing congestion within the air traffic control system indicate that higher-capacity aircraft will become an increasingly important part of the LCA market. Although the initial launch of this aircraft is expected to be based on a relatively small number of routes,[745] Boeing estimates eventual deliveries of 368 ultra-high capacity aircraft between 2000 and 2014, and Airbus estimates deliveries of 800 ultra-high capacity aircraft through 2014.[746] For all aircraft over 400 seats, including existing and new ultra-high capacity aircraft, Airbus estimates total demand of 1,332 and Boeing estimates demand for 696 non-replacement aircraft by 2017.[747]

The differences between Boeing's and Airbus's estimates of the 500-seat market are attributable to their divergent views of the way airline route structures will continue to develop. Aggregate passenger demand (revenue passenger-miles) can be estimated with a relatively high degree of confidence. However, estimating demand for specific segments of the aircraft market is considerably more uncertain because of the introduction of subjective factors, such as possible changes in airline route structures. In the 500-seat market, estimates of projected aircraft demand are sensitive to whether the expected growth in passenger demand will be satisfied using currently established route structures, or whether airlines further "fragment"[748] their service networks. For example, fragmentation implies expanding U.S.-Europe service by adding a Chicago-Brussels route rather than by increasing capacity on a New York-Paris route.

Boeing's projections assume that fragmentation will continue to be an important element in market expansions, resulting in lower estimates for the level of demand for 500-seat aircraft. Airbus's projections of the size of the 500-seat market are higher because Airbus discounts airlines' ability to continually satisfy growing demand with added flights. Without increasing flights, airlines must expand the seating capacity of aircraft fleets, resulting in higher demand projections for 500-seat aircraft.

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[744] Aerospace and airline industry representatives, interviews by USITC staff, Seattle, WA, Feb. 10-12; London, Mar. 30 and May 22; and Paris, Apr. 2, 1998.

[745] Aerospace and airline industry representatives, interviews by USITC staff, London, Mar. 30 and May 22, and Paris, Apr. 2, 1998.

[746] Airbus, *Global Market Forecast, 1998-2018*, p. 41; and Boeing, *1998 Current Market Outlook,* p. 49.

[747] Ibid. This category would include existing models of 747s, 777s, A330s, and A340s in high-density configurations.

[748] Fragmentation involves the use of a larger number of point-to-point routes between markets.

Although long-term market projections may suggest sufficient demand to warrant the development and production of an ultra-high capacity commercial aircraft, industry sources indicate that the market may not be large enough to support more than one manufacturer.[749] If the market can profitably support only one producer, the producer able to move into this market first will gain a significant long-term advantage.[750] Therefore, the decision to move toward the launch and production stages of either a derivative or new aircraft may be strongly influenced by the desire for first-mover advantage, anticipated benefits from bundling[751] aircraft sales, and expectations of demand growth that exceed current projections.

Approaches to the 500-Seat Market: Boeing and Airbus

At present, Boeing and Airbus are pursuing very different approaches to the development of an ultra-high capacity commercial aircraft. Airbus is focusing on the development of a completely new aircraft, whereas Boeing is concentrating its efforts on the development of modified versions of its existing 747 airframe.[752] Boeing is considering a version of the 747-400 with 416 seats and a range of 8,800 nautical miles, as well as an additional stretched version, with 500 seats and a range of 8,600 nautical miles.[753] Boeing already produces the 747-400 "Domestic," a special one-class, high-density, limited-range 747-400 derivative with 568 seats, which was ordered by several Japanese airlines.[754]

Currently, Airbus does not have an aircraft model with typical capacity in excess of 378 seats, a segment that has been solely supplied by Boeing's 747. Without an existing model to modify, Airbus has begun development of a completely new design to address the over-500-seat segment of the aircraft market. Called the A3XX-200 and A3XX-300, these aircraft are projected to seat between 555 and 656 passengers in a typical three-class configuration.[755] The aircraft will have the capacity to seat up to 1,000 in a high-density, one-class configuration,[756] with range estimates projected at 7,650-8,750 nautical miles. The design of this ultra-high capacity aircraft is likely to be decided in conjunction with the possibility of designing a smaller derivative that will allow Airbus to compete with a stretched Boeing 747 model.[757] The lack of a large capacity airliner currently places Airbus at a disadvantage when proposing package deals to airlines. Although

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[749] Aerospace and airline industry representatives, interviews by USITC staff, London, Mar. 30 and May 22, and Paris, Apr. 2, 1998.

[750] This is called the first-mover advantage and is characterized by economic structures in which there are: 1) a limited number of possible entrants, 2) productivity gains through learning, or 3) scale economies that confer cost or market share advantages to the first movers or entrants in a market.

[751] "Bundling" refers to the grouping of several different models of aircraft in one contract, and is also referred to as a "package deal."

[752] The minimum requirements of an all-new, clean-sheet aircraft may increase the price of the new product above what Boeing expects the market is willing to pay for this aircraft type.

[753] Polly Lane, "Boeing Studies Stretching Its 747 Jetliner," *The Seattle Times*, June 2, 1998, found at Internet address http://www.newsedge, retrieved June 3, 1998.

[754] Jackson, ed., *Jane's All the World's Aircraft, 1997-98,* p. 597.

[755] A typical three-class configuration consists of first, business, and coach classes.

[756] Jackson, ed., *Jane's All the World's Aircraft, 1997-98,* p. 184.

[757] The manufacturer's choice of specifications (range and capacity) for this aircraft depends on two offsetting factors. The more similar the specifications are to those of a competitor's aircraft, the smaller profits per sale are likely to be because the purchaser has a similar alternative. However, the more differentiated the specifications are from those of other aircraft at the upper end of the established market, the higher the profit potential per sale, but the smaller the demand base.

uncertainty exists regarding development costs and the price and specifications of the final product, industry sources state that Airbus must have a new aircraft at the upper end of the LCA market to extend its product family.[758]

Effect on the LCA Industry

The final outcome in the 500-seat segment may have significant long-term implications for LCA producers, suppliers, and the airlines. The eventual competitive scenario in the 500-seat market will be contingent on the ultimate number of producers of such an aircraft, that is, whether there is a two-producer scenario, whether there is one producer, or whether a cooperative arrangement emerges.[759] In general, the effect on suppliers and the effect on airlines will be similar for all scenarios.

With two 500-seat aircraft programs/producers, the impact on suppliers and airline customers generally will be positive; there will be additional opportunities for LCA suppliers to participate in one of the 500-seat programs, and airlines should benefit since orders can be open to competition between producers.[760] The impact on LCA producers if two 500-seat aircraft programs are launched depends critically on the ultimate size of the market for this aircraft, and first-mover advantage. If total demand in this market segment is actually large enough to accommodate two producers, each will benefit less than if it were the sole supplier, but will not be as disadvantaged as it would be in a scenario in which the market is not large enough for two 500-seat programs. In the long run, however, given the relatively low levels of projected demand and current production technology, a two-producer outcome may be somewhat unlikely.[761]

If ultimately a single 500-seat program is brought to market, both suppliers and airlines generally will be at a disadvantage vis-à-vis a two-supplier scenario. Airlines will face a single seller and so will be able to demand fewer price concessions, quality improvements, or design modifications. Suppliers will face a single buyer of components for that program, allowing the producer to extract more concessions than would be expected in a two-program market. The relative impact on the two LCA producers in a single-program market obviously depends on the identity of the one producer that brings the product to market and the viability of the program that is finally developed. Moreover, because bundling of aircraft sales is common practice among aircraft producers, and fleet commonality has been identified as a factor in fleet expansion decisions, the sole supplier of a 500-seat aircraft will have an advantage with respect to overall sales to major global airlines.

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[758] European airline official, interview by USITC staff, London, May 31, 1998.

[759] Boeing and Airbus worked jointly on developing an ultra-high capacity aircraft beginning in June 1994; however, the collaboration ended in mid-1995 with no substantial progress toward a concrete product specification. Jackson, ed., *Jane's All the World's Aircraft, 1996-97*, p. 164.

[760] An offsetting effect for airlines is that, to the extent that two suppliers reduce the economies of scale associated with the production of these aircraft, the costs of production will be higher for each copy produced. However, airlines are disadvantaged with two producers only if the cost savings associated with one producer were to be passed on to the airlines--a possibility that is not viewed as likely by the industry.

[761] European aerospace and airline industry representatives, interviews by USITC staff, London and Paris, Mar. 30, Apr. 2, and May 22, 1998.

If a joint development and production agreement among the LCA manufacturers leads to a single supplier outcome, there are no clear advantages or disadvantages to the individual LCA producers. The relative impact of producers will depend primarily on how the joint arrangement is organized. Airlines and suppliers will again face a single source for 500-seat aircraft, putting them at a disadvantage relative to the LCA producer.

External Factors Affecting the Global LCA Market

External factors,[762] such as new bilateral agreements that govern international traffic and developments in the air traffic control system,[763] may also have a significant impact on the market for LCA. New bilateral Open Skies arrangements are being negotiated to increase the freedom of airlines to choose and expand service on international routes, and through the eventual adoption of free flight, the air traffic control system is expected to handle increased air traffic capacity. As these changes are implemented, they will affect airline flight frequency and routing, helping to determine the number and types of aircraft commercial airlines will operate.

Open Skies

An Open Skies bilateral air service agreement enables airlines from one country to fly to any city in the other country as often as they wish, extend flights to third countries, also known as "beyond rights," and jointly market their services in code-sharing arrangements.[764] Generally, however, the accepted definition of a fully liberalized Open Skies agreement does not allow cabotage,[765] nor does it incorporate provisions on foreign ownership and control of U.S. carriers. The U.S. Department of Transportation (DOT) defines a fully liberalized Open Skies agreement to include:

- No limits on the number of airlines designated by either country
- Unrestricted capacity and frequency on all routes
- Unrestricted route and traffic rights, including no restrictions as to intermediate and beyond points
- Pricing flexibility
- Liberal charter arrangements

[762] Factors external to the LCA market are those factors not directly driven by the market for aircraft, but are regulatory practices and policies set by governmental and official bodies of the air transport industry.

[763] Air traffic control systems regulate the number of aircraft that can safely operate in a particular airspace.

[764] A code-sharing arrangement is an alliance between airlines whereby airlines share reservation computer codes, coordinate flight schedules, and allow single payments through either carrier for connecting flights to facilitate faster, more efficient transfer of passengers to final destinations.

[765] Cabotage is the transport of passengers between any two points in the same country. Therefore, Open Skies agreements do not allow foreign carriers to transport passengers point-to-point within the partner country.

- Ability to convert earnings and remit in hard currency promptly and without restriction

- Open code-sharing opportunities

- Self-handling provisions (the right of a carrier to perform and control its airport functions in support of its operations)

- Ability of carriers to enter freely into commercial transactions related to their flight operations

- Explicit commitment to nondiscriminatory operation of and access to computer reservation systems

- The option to exchange "seventh freedom"[766] rights for scheduled and charter all-cargo service [767]

Potential Benefits

Government perspective

The U.S. Government expects Open Skies agreements, as outlined above, to increase competition, decrease fares and freight rates, and increase trade and tourism in signatory countries.[768] Such agreements will increase access to international marketplaces and create additional airline industry related jobs. For example, according to the DOT, the transborder agreement with Canada[769] has resulted in an addition of $2 billion into the combined economies of the United States and Canada, and will expand economic activity by $15 billion by the year 2000.[770] Similarly, studies on the effects of an Open Skies agreement between the United States and Japan concluded that an agreement with beyond rights to other Asian markets would result in increased economic activity

[766] The "seventh freedom" is the right of one country's carriers to carry traffic between two foreign countries on a service with no connection to the home country.

[767] Office of the Assistant Secretary for Aviation and International Affairs, "Elements of Open Skies," found at Internet address http://www.ostpxweb.dot.gov/aviation/IntAv/OpenSky.htm, retrieved Sept. 22, 1997.

[768] U.S. Department of Transportation (DOT) representative, telephone interview by USITC staff, Jan. 15, 1998.

[769] The United States signed an open transborder agreement with Canada in February 1995 that does not grant beyond rights to U.S. carriers.

[770] Federal Aviation Administration (FAA), *21st Annual FAA Commercial Aviation Forecast Conference: Proceedings*, FAA-APO 96-3, (Washington, DC: Office of Aviation Policy and Plans, 1996), p. 20.

and U.S. jobs based on expanded traffic between the two countries.[771] However, the studies did not consider the capacity constraints of Japanese airports nor did they account for the possibility of an agreement like that eventually reached between the United States and Japan, which falls short of full Open Skies.

Airline perspective

A full Open Skies agreement permits air carriers to utilize the most cost-efficient aircraft for individual routes without limitations by governments, allowing them to provide levels of service commensurate with market demand.[772] As a result, airlines anticipate increased demand for LCA in previously restricted markets. However, the benefits of Open Skies are likely to be less significant in markets with considerable capacity constraints, existing liberal access, or a small number of dominant carriers that may control sufficient takeoff and landing slots to prevent entry.[773]

The Open Skies agreements in place enable airlines to use any-sized aircraft without restriction in service to/from the signatory countries. Airlines will ultimately use those aircraft that best fit the economics of each route, making it difficult to predict which size aircraft will be most affected. Airlines that place more importance on beyond rights than increased access to a country may seek to establish distribution networks[774] in certain countries, utilizing smaller aircraft to transport passengers to third countries. For example, U.S. airlines carry approximately 1.4 million passengers annually between Japan and the rest of the Asian market.[775] Therefore, fifth-freedom[776] traffic with Japan is an important element of U.S. airline competition in this market, and inclusion of beyond rights for existing traffic may allow U.S. airlines to build an Asian Open Skies network.

Competition is likely to be limited by capacity constraints, and the increasing prevalence of airline alliances suggests that the right to code-share may diminish the importance of beyond rights as airlines establish service to new destinations through their foreign partners rather than creating

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[771] ACCESS U.S.-Japan, *The Impact of Increased Passenger Flights to Japan on U.S. Employment*, found at http://www.accessusjapan.org, retrieved Dec. 18, 1997. The U.S.-Japanese market encompasses 11 million passengers annually and over $10 billion in revenue; U.S. airlines transport two-thirds of this traffic. Paul Stephen Dempsey, “Flying into Trade Headwinds, Northwest has Agenda in Pushing for Open Skies,” http://www.newsedge, retrieved Nov. 28, 1997.

[772] Kang Siew Li, “Northwest to Make Comeback,” http://www.newsedge, retrieved June 26, 1997.

[773] Compiled from responses to USITC airline questionnaire, Feb. 1998.

[774] These networks would differ from hubs because flights must originate from the United States. The right to establish foreign hubs is a seventh freedom right and is not part of a standard Open Skies agreement.

[775] J.A. Donoghue, “Getting a Grip on the Gripes,” *Air Transport World*, Feb. 1996, p. 51.

[776] The five freedoms of air transport were a result of the Chicago Convention of 1944. They pertain to the right to (1) fly over another nation, (2) land in another nation without picking up or disembarking passengers, (3) disembark in another nation passengers that boarded in the carrier’s home country, (4) carry passengers of another nation to the carrier’s home country, and (5) carry passengers from one foreign country to another. Governments can choose to either grant or deny any of these freedoms, and thereby partially or fully restrict the access of carriers to their airspace. In Open Skies agreements, beyond rights refer to fifth freedom traffic. Not formally part of the original convention, the sixth freedom is the right to carry traffic between two other countries via an airport in a carrier’s own territory. The seventh freedom right to provide stand alone service between two countries also is not formally part of the original convention.

new service themselves.[777] To the extent that competition intensifies, the importance of operating costs could become a greater factor in choosing aircraft, which could spur demand for LCA with lower operating costs.[778]

Passenger perspective

As Open Skies agreements encourage new routes and allow greater flight frequency, travelers using international air transportation will benefit from higher levels of convenience (e.g., a greater number of direct flights) and possibly lower fares due to increased competition on specific routes. For example, since the transborder agreement[779] between the United States and Canada was signed in February 1995, traffic has increased by 28 percent, 17 additional U.S. cities have received nonstop scheduled or charter services, and fares have decreased in the top 50 markets by an average of 22 percent from February 1995 through February 1997.[780]

Global Implementation Status

Recent U.S. efforts to liberalize global aviation services have yielded agreements with many countries. On March 31, 1992, the U.S. Secretary of Transportation announced the first in a series of initiatives that led to the Open Skies Initiative in Europe and agreements with 12 European countries.[781] In 1996, the United States launched the U.S.-Asian Open Skies Initiative, resulting in agreements with several Asian-Pacific nations, including Singapore, Taiwan, Brunei, Malaysia, and New Zealand. Six Latin American countries and Aruba signed agreements with the United States during 1996-97. To date, the United States has signed 32 full Open Skies agreements and a number of partial air service agreements.

In June 1997, the United States proposed a set of talks with other nations designed to work toward an open global market in international aviation services. At present, the United States is involved in talks with the United Kingdom and Italy, and recently concluded agreements with Japan, Korea, and France. These agreements liberalize air traffic but are not full Open Skies agreements.[782] For example, only the three so-called incumbent U.S. carriers (Northwest Airlines, United Airlines, and Federal Express) may fly between any U.S. city and any Japanese city, as can All Nippon Airways and Japan Airlines.

U.S. negotiations with the United Kingdom remain deadlocked over issues pertaining to the proposed alliance between British Airways and American Airlines. The U.S. Government has made an Open Skies agreement a precondition for approval of the proposed alliance, whereas the European Union (EU) Commission has cautioned that an alliance would provide the two airlines

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[777] Compiled from responses to USITC airline questionnaire, Feb. 1998.

[778] Ibid.

[779] The transborder agreement does not allow beyond rights.

[780] Statement of Theodore E. Mathison, Executive Director, Maryland Aviation Administration, Airports Council International, testimony before the U.S. House Aviation Subcommittee of the Transportation and Infrastructure Committee, July 31, 1997.

[781] Angela Edwards, "Foreign Investment in the U.S. Airline Industry: Friend or Foe?" *Emory International Law Review*, Vol. 9, Fall 1995, No. 2, found at Internet address http://www.law.emory.edu/EILR/volumes/fall95/edwards.html, retrieved July 15, 1997.

[782] According to the aforementioned DOT criteria.

with 60 percent of the scheduled passenger traffic to the United Kingdom.[783] British Airways currently controls sufficient landing slots at London's Heathrow International Airport to hinder competition with U.S. and other airlines, and the United States and the United Kingdom disagree on the number of landing slots British Airways should cede.

Free Flight

Free flight is an air traffic management (ATM) concept that allows pilots, under certain circumstances, to select their flight path and aircraft speed in real time, and file the most efficient and economical flight plans, taking into account weather patterns and aircraft operating characteristics.[784] As the current air traffic control (ATC) system becomes overloaded because of increased traffic volumes, and the U.S. National Airspace System (NAS) nears capacity in some markets,[785] routings have become circuitous, resulting in significant delays. Under free flight, pilots have the latitude to avoid congested airways and choose more direct flights with the assistance of Global Positioning System[786] (GPS) enhanced surveillance.[787] Air traffic managers would impose restrictions only to ensure aircraft separation, preclude exceeding airport capacity, prevent unauthorized use of Special Use Airspace,[788] and ensure flight safety. The effect on demand for LCA will depend on the degree to which free flight works to expand the capacity of air traffic systems, and the number of world regions that implement free flight. Free flight may also have an effect on the demand for different types of aircraft. If a more efficient ATM system encourages short-haul, direct flights, airlines may demand smaller aircraft in greater quantities in order to increase flight frequency.

Potential Benefits

Government perspective

The U.S. Government's stated goals are to improve the safety and efficiency of the NAS,[789] and an air traffic control modernization plan implemented under a free-flight concept will be the means to achieving these goals. Automation and more precise location accuracy is intended to decrease

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[783] Neil Buckley, "BA Accuses Brussels of Sloppiness," http://www.newsedge, retrieved Sept 6, 1997.

[784] Currently, the FAA assigns a flight path between the airline-specified origin and destination.

[785] An FAA forecast projects U.S. domestic traffic growth of 3.9 percent per year from 1996 to 2015. FAA, *7th Annual FAA General Aviation Forecast Conference*, FAA-APO-97-3, (Washington, DC: Office of Aviation Policy and Plans, 1997), p. 69.

[786] GPS uses a constellation of satellites and radio signals to determine the position, velocity, and altitude of GPS-equipped aircraft.

[787] GPS locates aircraft with precision, and aircraft are able to broadcast their positions automatically (via datalink) to other aircraft and ATM centers, where computers monitor possible flight path conflicts.

[788] Special Use Airspace refers to airspace of defined dimensions wherein activities must be confined because of their nature, or wherein limitations are imposed upon aircraft operations that are not a part of those activities, or both. 14 CFR 73.3.

[789] *Final Report to President Clinton*, White House Commission on Aviation Safety and Security, Feb. 12, 1997.

human error. For example, local area augmentation systems, which increase the accuracy of GPS system ground stations, would increase the safety of the system, allowing precision approaches to airports even in bad weather with limited visibility.[790]

Airline perspective

Free flight may result in considerable savings for airlines by allowing them to use aircraft in the most efficient manner--at the most optimal speeds, altitudes, and routes--rather than along rigidly defined airways.[791] The resulting savings in operating costs occur primarily in the form of lower fuel costs and other costs related to the number of hours flown,[792] but the alleviation of congestion and capacity constraints in addition to the aforementioned savings in time and fuel would increase airlines' ability to meet growing demand, and would work with Open Skies agreements to expand air traffic.

However, uncertainty remains in the airline industry as to whether the funds for NAS modernization will be available in the near future, and what the costs will be for airlines to accommodate retrofitting and retraining. Airlines anticipate significant upgrade costs and expect legislative delays with respect to the authorization of funds, making it difficult for them to justify the scheduling of such upgrades.[793] Without a clear schedule of modernization, the benefits to airlines of free flight may be delayed.[794]

Passenger perspective

The potential benefits to passengers are primarily improved convenience and safety. The forestallment of gridlock in the NAS is an obvious benefit to the increasing number of passengers traveling by air. Free flight may result in fewer delays, shorter flights, and increased safety. Moreover, airlines may be able to provide passengers with a greater number of direct flights or new service to more convenient airports.

Global Implementation Status

In 1994, the RTCA[795] Free Flight Task Force, a joint government/industry body composed of approximately 250 specialists from all facets of the U.S. aviation industry, was established to study and make recommendations on free flight in the United States. At the same time, the Commission on Aviation Safety and Security called for free flight implementation by the year 2005. In response to this directive, the FAA's Flight 2000[796] program was established to reorganize airborne and ATC procedures and equip approximately 2,000 aircraft and air traffic facilities in Alaska and Hawaii with the necessary avionics, with the FAA providing the shipsets

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[790] FAA representative, telephone interview by USITC staff, Mar. 26, 1998.

[791] "FAA and Aviation Community to Implement Free Flight," FAA Press Release, Mar. 15, 1996.

[792] Compiled from responses to USITC airline questionnaire, Feb. 1998.

[793] Ibid.

[794] Ibid.

[795] Formerly the Radio Technical Commission for Aeronautics, and unofficially known as Requirements and Technical Concepts for Aviation since incorporation.

[796] The program is estimated to cost $350-$450 million. David W. Robb and Bill Carey, "Flight 2000 and Beyond," *Avionics Magazine*, June 1997, p. 22.

of avionics and reimbursing the cost of installation.[797] The project will determine the nominal benefits of free-flight technologies and uncover some of the problems associated with making the transition from the current air traffic control (ATC) system to a free-flight ATM system.

The EU Commission is monitoring projects similar to Flight 2000 in Europe. However, the programs in the United States and Europe have some differences. For example, because the FAA favors a more advanced protocol, it does not conform to the International Civil Aviation Organization standards[798] of Aeronautical Telecommunications Network[799] message-format used by the EU.[800] If different systems are implemented in Europe and the United States, the operating costs for airlines could significantly rise, and the possibility of error by pilots and the ATM system could increase.

Implications for the Competitiveness of the U.S. LCA Industry

100-Seat Programs

New 100-seat programs have the potential to increase global LCA demand by giving airlines a more cost-effective means by which to respond to previously untapped markets. Since Boeing is currently the only LCA manufacturer producing an aircraft specifically designed as a 100-seat model, development of the airline passenger market for this aircraft is likely to be of strong benefit to Boeing and the U.S. aerospace industry. However, this presupposes that the aircraft can be sold at a relatively low per-unit price, necessary for the aircraft to succeed in the global market. A new, competitively priced, 100-seat aircraft may enable a wave of airline entry based on lower costs. It may also enable major airlines to respond to increased competitive pressures from lower-cost airlines by employing aircraft specifically designed for the 100-seat market. These aircraft will be used to service new markets, increase frequencies, and replace older aircraft on a more cost-competitive basis.

Although Boeing's and Airbus's introduction of new 100-seat aircraft represents a product line expansion that could position the LCA manufacturers against additional competitors, this is unlikely to put competitive pressure on the remainder of Boeing's and Airbus's product lines. Instead, competition in the 100-seat market is likely to put comparatively more pressure on new entrants and regional airframers rather than on the established LCA producers, as analysis indicates that proposed 100-seat programs occupy a separate niche in the market for LCA.

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[797] Robb and Carey, p. 20.

[798] The International Civil Aviation Organization acted as a forum through which the world aviation community adopted message-format standards. J.A. Donoghue, "Diverging Courses," *Air Transport World*, Mar. 1997, p. 65.

[799] The Aeronautical Telecommunications Network is designed to facilitate communications between aircraft and ground-based airline and air traffic control systems. "Report of the Federal Internetworking Requirements Panel," The Energy Sciences Network, found at Internet address http://www2.es.net/pub/nist/firp/firp-report.txt, retrieved Jan. 18, 1997.

[800] J.A. Donoghue, *Diverging Courses*, p. 65.

Heightened direct competition among LCA and regional aircraft producers has the potential to produce some industry rationalization and result in the attrition of weaker producers**. However, because of the strategic importance governments perceive in the manufacture of aircraft, such direct competition** has the potential to generate more foreign government involvement in this aircraft market.

500-Seat Programs

As Boeing can develop a lower-cost derivative that can compete at the lower end of the market for a new ultra-high capacity aircraft produced by Airbus, it is unlikely that Boeing's dominance in the over-400-seat market sector will be threatened in the short to mid term. Nevertheless, because Airbus currently does not have an aircraft model with capacity typically greater than 378 seats, it may be competitively advantageous for the company to invest in the development of a larger aircraft to gain first-mover benefits in the potential market for aircraft with a capacity greater than the current 747, and to compete at the high end of the market segment dominated by Boeing. The ultimate effect of the development of ultra-high capacity aircraft programs on the U.S. LCA industry is somewhat uncertain, however. The combination of an over-500-seat aircraft's greater capacity, limited number of congested high volume routes, and projected purchase price of more than
$200 million[801] is likely to result in a fairly small market for this aircraft. The impact on both U.S. and foreign LCA manufacturers and suppliers will depend on the ultimate size of the market and the characteristics of the particular aircraft that each producer brings to market.[802]

External Factors

Although recent changes to external factors influencing the LCA market will also affect the competitiveness of LCA producers by influencing the size of the market for specific aircraft types, such external factors are not likely to affect Boeing and Airbus differently. Relative competitiveness will depend on how well each producer can recognize and respond to these structural changes that will affect airline operations. For example, advances in air traffic control may allow airlines to fragment service by temporarily improving airport capacity; this may reduce the immediate need for ultra-high capacity airliners but increase interim demand for 100-seat aircraft. Nevertheless, in the longer term, demand for 500-seat aircraft will continue to grow if infrastructure limitations remain.

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[801] Early projections estimated a purchased price of $200 million in 1996 dollars. Anne Swardson, *Airbus: No. 2 and Flying Higher*, Washington Post Foreign Service, Nov. 26, 1996, p. D-1, found at Internet address http://www.washingtonpost.com/wp-srv/inatl/daily/dec/02/airbus/airbus.htm.

[802] The range of possibilities includes the scenario that one or both producers may ultimately decide not to bring an aircraft with these characteristics to market.

CHAPTER 7
PRINCIPAL FINDINGS

Changing Structure of the U.S. and West European LCA Industry

The current competitive environment of the global large civil aircraft (LCA) manufacturing sector is shaped by the duopoly created by the Boeing-McDonnell Douglas merger and the major restructuring occurring at both Boeing and Airbus. During this transition phase, both companies have an opportunity to develop a competitive edge in the marketplace by increasing production efficiencies and consolidating operations to reduce costs and gain or maintain market share.

Each company must overcome significant obstacles before its restructuring process is complete. Although Boeing acquired a greatly enlarged defense sector business to soften the cyclical nature of the LCA industry (in addition to the expertise and capabilities of a former competitor), Boeing has had difficulties meshing the corporate policies and cultures of the two companies and integrating their overall operations. Moreover, the emergence of production line problems at the time of the merger has led to considerable financial losses for Boeing over the past year. The company may also have to cope with the slower response times and decreased flexibility inherent in a larger and more diversified corporate structure.

At the same time, Airbus is attempting to rationalize its corporate structure to achieve greater operating efficiencies and responsiveness. Its effort to create a single corporate entity will, if realized, potentially lead to a more streamlined and cost-conscious firm. To accomplish its goal of achieving maximum performance levels, Airbus will need to lift its internal restrictions on operating flexibility--such as limitations on outsourcing and financing options--and resolve deep-rooted partner differences. Airbus's responses to future market demands and cyclical fluctuations may best demonstrate the company's ultimate ability to perform as a market-driven, cohesive entity.

Price competition between Boeing and Airbus has intensified as the LCA market increasingly focuses on unit and operating costs. Consequently, technological innovation has been directed toward improving aircraft manufacturing processes in an effort to reduce airframers’ internal production costs. In addition, cost reductions are being pursued throughout the LCA supply chain via several strategies, including risk-sharing projects with producers of major components, as the two remaining major LCA producers seek to shift more design and financing responsibilities further down the supply chain.

Potential Competition from Russian and Asian Manufacturers

In contrast to Western LCA producers, Russian and Asian manufacturers lack certain key competitive factors, including capital, core technologies, efficient corporate structures, and global support networks, which impede their entry as global LCA producers. To improve their competitiveness, the Russian airframe design and manufacturing industry needs Western subassemblies--engines and avionics--whereas the Asian industry, which lacks the comprehensive skills necessary to support an indigenous aircraft program, needs additional subcontract and codevelopment work with Western producers on LCA programs. Collaborative arrangements with Western LCA manufacturers and suppliers could provide training, experience, and technology transfer to the Russian and Asian industries, which may strengthen their capabilities and allow some countries to compete in the long run.

Russian LCA producers are not likely to be in a position to secure global market share in the next 10 years, thereby presenting virtually no competitive challenge to the U.S. LCA industry during that time frame. Notwithstanding the fact that the Russian industry has excellent designers and engineers, and has been designing and producing civil aircraft for its domestic and satellite markets for decades, myriad problems plague the industry. The primary obstacle is the lack of capital, followed by disjointed corporate structures, and a lack of a focused, comprehensive approach to these problems by the Russian Government.

Western LCA manufacturers and components suppliers are pursuing various types of projects with Russian companies. These linkages should enable Western LCA manufacturers and components suppliers to benefit from Russian design engineering, research, and manufacturing capabilities, and increase access to what can be considered one of the remaining untapped markets in the world. The success of this market access strategy may be tempered by the current internal Russian debate with respect to the degree of market access Western LCA manufacturers should be granted.

Although Asian nations are pursuing advanced technologies and capabilities in the commercial aircraft industry, it is unlikely that Asian aerospace entities will present significant direct competition to established manufacturers of LCA in the next 15-20 years. However, as several Asian manufacturers act as suppliers or subcontractors in joint development programs, the competitive position of U.S. suppliers to the LCA industry may be adversely affected.

China's aspirations to manufacture LCA are inhibited by deficiencies in basic technological and managerial competencies and the lack of a modern manufacturing infrastructure. However, the potential size of the Chinese market for aircraft gives the Chinese aerospace sector a two-fold competitive advantage. First, the combination of strong expected demand and lingering government influence in aircraft purchases creates a large potential market for future Chinese-produced LCA. Second, Western producers' market access interests help to promote subcontracting, risk-sharing, codesign, and joint development projects, which provide opportunities for technology transfer and increased training and aircraft-related manufacturing experience. Benefits of such contracts to the U.S. LCA industry include market access, as stated, as well as the sharing of risk and access to cost-competitive suppliers.

As a result of the recent Asian financial crisis, the Korean and Indonesian aerospace industries are constrained by limited access to capital. Korea has technical and subcontracting experience, but has been unable to come to agreement with foreign partners for its regional aircraft development program. Indonesia has historically enjoyed significant government support, but lacks a universal acceptance of Western airworthiness standards and a developed supplier base for parts and raw materials. Moreover, the likelihood of continued government funding or private capital infusions in the near term appears exceedingly low.

Singapore, Japan, and Taiwan are other Asian participants in the LCA industry. With respect to LCA manufacture, each is constrained by comparatively small geographical space and distinct production capabilities. As a result, it is unlikely that they will assume more than a subcontracting or risk-sharing role in aircraft programs.

New Market Segments and External Market Factors

Boeing appears likely to retain a competitive advantage with respect to the new 100- and 500-seat programs, although the ultimate impact on U.S. competitiveness will depend on how well each product meets airline needs, the size of the global market, program profitability, and any first-mover advantage. New air traffic developments, including Open Skies bilateral agreements and free flight, may indirectly affect LCA demand by changing demand for different types of aircraft, but are not likely to affect Boeing or Airbus differently. Relative competitiveness will depend on the degree to which each producer can cope with market changes that apply to all.

In the 100-seat market, Boeing will gain first-mover advantages with the 717-200 aircraft program it acquired from McDonnell Douglas. Nevertheless, Airbus will likely enter this niche with a shortened version of an existing model. Since Boeing is currently closest to delivering an aircraft specifically designed for the 100-seat market, any further airline development of this passenger market is likely to be of benefit to Boeing and the U.S. aerospace industry. The entry of Boeing and Airbus into the 100-seat market will also heighten competition in this product niche. This will put comparatively more pressure on regional aircraft manufacturers than on the LCA producers, who have the competitive advantage of significant resources and a broad family of products, and make it more difficult for aspiring producers to succeed.

As Boeing can develop a lower-cost derivative aircraft that can compete at the lower end of the ultra-high capacity market, it is unlikely that Boeing's dominance in the over-400-seat market will be threatened by Airbus in the short to mid term. However, in order to compete in all segments of the LCA market and thereby increase the appeal of its entire product line, Airbus has stated that it needs to develop a larger aircraft. The success of the A3XX program will depend on Airbus's ability to differentiate its product from Boeing models by offering greater capacity and optimal range capabilities within competitive operating cost parameters. If either Boeing or Airbus eventually manufactures an ultra-high capacity aircraft, the impact on U.S. and foreign LCA suppliers will depend on the ultimate size of the market and the characteristics of the aircraft that are produced.

Open Skies bilateral agreements and the modernization of air traffic control through the implementation of free flight will change the way airlines use their fleets, thus indirectly affecting the markets for new aircraft. Open Skies treaties may increase traffic, which would positively affect the demand for aircraft and parts. Free flight may postpone or alleviate capacity constraints; this, in turn, will help to determine an airline’s mix of aircraft, perhaps leading to a diminished projection in the short run for larger capacity aircraft. Each LCA manufacturer’s ability to predict and respond to such changes in demand will determine its competitive advantage.

APPENDIX A

REQUEST LETTER

COMMITTEE ON WAYS AND MEANS

U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515-6348

August 13, 1997

DOCKET NUMBER 1963
Office of the Secretary
Int'l Trade Commission

97 AUG 18 P1:14

The Honorable Marcia E. Miller
Chairman
U.S. International Trade Commission
500 E Street, S.W.
Washington, D.C. 20436

Dear Chairman Miller:

The Committee on Ways and Means is interested in obtaining current information on the global competitiveness of the U.S. large civil aircraft industry. The Committee is seeking a report similar in scope to the report submitted to the Senate Committee on Finance by the U.S. International Trade Commission in August 1993. That report was initiated under section 332(g) of the Tariff Act of 1930 (USITC Inv. No. 332-332, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft*, Publication 2667).

Since the study was completed, there have been many important developments in the global large civil aircraft industry. In order to better assess the current market conditions confronting the U.S. industry, I request that the U.S. International Trade Commission conduct an investigation under section 332(G) of the Tariff Act of 1930 [19 U.S.C. 1132 (g)] and provide a report setting forth the results of the investigation.

The report should include:

- changes in the structure of the global large civil aircraft industry, including the Boeing-McDonnell Douglas merger, the restructuring of Airbus Industrie, the emergence of Russian producers, and the possibility of Asian parts suppliers forming consortia to manufacture complete airframes;

- developments in the global market for aircraft, including the emergence of regional jet aircraft and proposed jumbo jets, and issues involving "open skies" and "free flight";

- implementation and status of the 1992 U.S.-EU Large Civil Aircraft Agreement; and

- other significant developments that affect the competitiveness of the U.S. large civil aircraft industry.

The report should focus on the period 1992-96, and to the extent possible, 1997.

The Committee requests that the Commission transmit its report to Congress no later than fifteen months following the receipt of this request. It is the Committee's intent to make the Commission's report available to the public in its entirety. Therefore, the report should not contain any confidential business information.

Thank you for your attention to this request. With best personal regards,

Sincerely,

Bill Archer
Chairman

cc: The Honorable Philip M. Crane
The Honorable Charles B. Rangel
The Honorable Robert T. Matsui

APPENDIX B

FEDERAL REGISTER NOTICE

Application and Permit, authorized by the regulations at 43 CFR parts 3620 and 5510. The form contains information that BLM uses to determine whether or not the timber, plant or mineral material applied for qualifies for free use and whether or not disposal is consistent with land-use plans and to ensure that the appropriate BLM administrative office is issuing the permit.

Bureau Form Number: 5510–1.

Frequency: On occasion, as applied for.

Description of Respondents: Respondents are generally individuals who are procuring timber, other vegetative or mineral materials for personal or construction use.

Estimated Completion Time: 30 minutes (0.5 hour) per response.

Annual responses: 430.

Annual Burden Hours: 215.

Bureau Collection Clearance Officer: Carole Smith, (202) 452–0367.

Dated: August 28, 1997.

Carole Smith,

Bureau of Land Management Information Clearance Officer.

[FR Doc. 97–25986 Filed 9–30–97; 8:45 am]

BILLING CODE 4310-84-M

DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Pima-Maricopa Irrigation Project Final Programmatic Environmental Impact Statement

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of availability of the final programmatic environmental impact statement; INT–FES 97–30, Filed September 26, 1997.

SUMMARY: The Gila River Indian Community (Community) and the Bureau of Reclamation (Reclamation) have prepared a Final Programmatic Environmental Impact Statement (PEIS) on the Pima-Maricopa Irrigation Project (Project) in compliance with the National Environmental Policy Act of 1969, as amended, and other applicable environmental laws. The purpose of the final PEIS is to assist in decision making by the Commissioner of Reclamation regarding the approval of construction-related expenditures of funds authorized for the Central Arizona Project (CAP) to implement portions of the Project within the constraints of law. Any project that involves a major Federal action, such as Federal funding, permitting or approval, must comply with NEPA.

This final PEIS describes four alternatives for rehabilitation of 66,000 acres and new development of 80,330 acres of irrigated agricultural lands. The proposed action is to rehabilitate San Carlos Indian Irrigation Project (SCIIP) facilities and build new facilities both on and off the Reservation. Ultimate project size would be 146,330 acres, which will enable the Gila River Indian Community to better utilize water supplies and provide additional economic employment opportunities. A No Federal Action alternative is also described.

The Community is the Project proponent and is responsible for the preparation of this final PEIS through a Self-Governance Agreement with Reclamation. Reclamation is responsible for disbursing CAP-related Federal funds and functions as the lead Federal agency for the Project. The Bureau of Indian Affairs (BIA) is a cooperating agency in this process because of its trust responsibility and administration of SCIIP.

ADDRESSES: Single copies of the final PEIS may be obtained on request. Requests for copies should be addressed to: Mr. Bruce D. Ellis (PXAO–1500), Bureau of Reclamation, PO Box 9980, Phoenix, AZ 85068. Copies may also be requested by telephone at (602) 395–5683.

Copies of the final PEIS are available for inspection at the address above and also at the following locations:

Office of the Commissioner, Bureau of Reclamation, Room 7612, 849 C Street, NW, Washington DC 20240

Reclamation Service Center, Bureau of Reclamation, Library, Room 167, Building 67, Denver Federal Center, Denver CO 80225

Lower Colorado Region, Bureau of Reclamation, Library, Room 105, Mead Building, 3 Miles South on Buchanan Boulevard, Boulder City NV 89005.

Libraries

Arizona Department of Library Archives and Public Records, Phoenix AZ

Phoenix Public Library, Phoenix AZ

Chandler Public Library, Chandler AZ

Florence Public Library, Florence AZ

Coolidge Public Library, Coolidge AZ

Arizona Collection, Hayden Library, Arizona State University, Tempe AZ

University of Arizona, Main Library, Tucson AZ

Ms. Rebecca Burke, Government Document Service, Arizona State University, Tempe AZ.

FOR FURTHER INFORMATION CONTACT: Mr. Bruce D. Ellis (PXAO–1500), Bureau of Reclamation, PO Box 9980, Phoenix, AZ 85068; telephone: (602) 395–5685.

SUPPLEMENTARY INFORMATION: The recommended plan proposes construction of a common-use irrigation system to deliver water to 146,330 acres within the Gila River Indian Reservation (Reservation) and to rehabilitate SCIIP Joint Works facilities. The recommended plan, known as the Project, represents a component of the Community's Master Plan for Land and Water Use (Franzoy Corey, 1986). The Master Plan identifies the Community's major goals and preferences for improving and developing Reservation land and water resources.

The Project would support the continued role of agriculture as a primary element of the Community's traditional economy and way of life. The Project would enhance economic growth, development and self-sufficiency of the Community. The Project has the potential to significantly improve the standard of living for Community members. No significant changes have been made to the recommended plan as presented in the draft PEIS (DEIS 96–46).

The final PEIS presents the recommended plan, alternatives, and the no Federal action alternative. The document describes the existing environment and analyzes, at a programmatic level, the environmental consequences of project construction. The final PEIS also includes responses to comments received during the 60-day public review and hearing process on the draft statement.

Dated: September 26, 1997.

V. LeGrand Neilson,

Assistant Regional Director.

[FR Doc. 97–25987 Filed 9–30–97; 8:45 am]

BILLING CODE 4310-94-P

INTERNATIONAL TRADE COMMISSION

[Investigation No. 332–384]

The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competiveness of the U.S. Industry

AGENCY: United States International Trade Commission.

ACTION: Institution of investigation and scheduling of public hearing.

EFFECTIVE DATE: September 23, 1997.

SUMMARY: Following receipt of a request on August 18, 1997, from the House Committee on Ways and Means, the Commission instituted investigation No. 332–384, The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry, under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)).

FOR FURTHER INFORMATION CONTACT: Industry-specific information may be obtained from Mr. Peder Andersen (202–205–3388), Office of Industries, U.S. International Trade Commission, Washington, DC 20436. For information on the legal aspects of this investigation contact Mr. William Gearhart of the Office of the General Counsel (202–205–3091). The media should contact Ms. Margaret O'Laughlin, Office of External Relations (202–205–1819). Hearing impaired individuals are advised that information on this matter can be obtained by contacting the TDD terminal on (202) 205–1810.

Background

As requested by the House Committee on Ways and Means in a letter dated August 13, 1997, the Commission, pursuant to section 332(g) of the Tariff Act of 1930, has instituted an investigation and will prepare a report examining key developments pertinent to the competitiveness of the U.S. large civil aircraft industry, focusing on the period 1992–96, and to the extent possible, 1997. The Commission will address changes in the structure of the global large civil aircraft industry, including the Boeing-McDonnell Douglas merger and the restructuring of Airbus Industrie. The report will also examine the emergence of Russian producers of large civil aircraft and the potential for Asian parts suppliers to form consortia to manufacture airframes. In addition, the Commission will address the implementation and status of the 1992 U.S.-EU Large Civil Aircraft Agreement, developments in the global market for aircraft, including the emergence of markets for regional jet aircraft and jumbo jets, issues involving "open skies" agreements and "free flight" systems, as well as other developments affecting the competitiveness of the U.S. industry.

The report in this investigation will be similar in scope to the report prepared by the Commission in investigation No. 332–332, Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Large Civil Aircraft, prepared at the request of the Senate Committee on Finance and transmitted to the Committee in August 1993. The report was published in August 1993 (USITC Publication 2667) and may be accessed through the USITC Internet server (http://www.usitc.gov or ftp://ftp.usitc.gov).

Public Hearing

A public hearing in connection with the investigation will be held at the U.S. International Trade Commission Building, 500 E Street SW, Washington, DC, beginning at 9:30 a.m. on March 17, 1998. All persons will have the right to appear, by counsel or in person, to present information and to be heard. Requests to appear at the public hearing should be filed with the Secretary, United States International Trade Commission, 500 E Street SW, Washington, DC 20436, no later than 5:15 p.m., March 3, 1998. Any prehearing briefs (original and 14 copies) should be filed not later than 5:15 p.m., March 3, 1998; the deadline for filing post-hearing briefs or statements is 5:15 p.m., March 31, 1998. In the event that, as of the close of business on March 3, 1998, no witnesses are scheduled to appear at the hearing, the hearing will be cancelled. Any person interested in attending the hearing as an observer or non-participant may call the Secretary of the Commission (202–205–1816) after March 3, 1998 to determine whether the hearing will be held.

Written Submissions

In lieu of or in addition to participating in the hearing, interested parties are invited to submit written statements concerning the matters to be addressed by the Commission in its report on this investigation. Commercial or financial information that a submitter desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. All submissions requesting confidential treatment must conform with the requirements of section § 201.6 of the Commission's Rules of Practice and Procedure (19 CFR 201.6). All written submissions, except for confidential business information, will be made available in the Office of the Secretary of the Commission for inspection by interested parties. To be assured of consideration by the Commission, written statements relating to the Commission's report should be submitted to the Commission at the earliest practical date and should be received no later than the close of business on March 31, 1998. All submissions should be addressed to the Secretary, United States International Trade Commission, 500 E Street SW, Washington, DC 20436.

Persons with mobility impairments who will need special assistance in gaining access to the Commission should contact the Office of the Secretary at (202) 205–2000. General information concerning the Commission may also be obtained by accessing its Internet server (http://www.usitc.gov).

Issued: September 24, 1997.

By order of the Commission.

Donna R. Koehnke,

Secretary.

[FR Doc. 97–26021 Filed 9–30–97; 8:45 am]

BILLING CODE 7020–02–P

INTERNATIONAL TRADE COMMISSION

[Inv. No. 337–TA–383]

Certain Hardware Logic Emulation Systems and Components Thereof; Notice of Commission Determination Granting Complainant's Petition to Modify the Amount of Respondents' Temporary Relief Bond

AGENCY: U.S. International Trade Commission.

ACTION: Notice.

SUMMARY: Notice is hereby given that the Commission has determined to grant complainant's petition to modify respondents' temporary relief bond in the above-captioned investigation. Respondents' temporary relief bond for all entries made since issuance of temporary relief in this investigation remains at 43 percent of the entered value of the subject imported articles if entered value equals transaction value as defined in applicable U.S. Customs Service regulations. Respondents' temporary relief bond for all entries made since issuance of temporary relief in this investigation is increased to 180 percent of the entered value of the subject imported articles if entered value does not equal transaction value as defined in applicable U.S. Customs Service regulations.

FOR FURTHER INFORMATION CONTACT: Jay H. Reiziss, Esq., Office of the General Counsel, U.S. International Trade Commission, telephone 202–205–3116.

SUPPLEMENTARY INFORMATION: This investigation and temporary relief proceedings were instituted on March 8, 1996, based upon a complaint and motion for temporary relief filed on January 26, 1996, by Quickturn Design Systems, Inc. ("Quickturn"). 61 Fed. Reg. 9486 (March 8, 1996). The respondents are Mentor Graphics Corporation of Wilsonville, Oregon ("Mentor") and Meta Systems of Saclay, France ("Meta") (collectively "respondents"). The products at issue are hardware logic emulation systems that are used in the semiconductor manufacturing industry to test

APPENDIX C

CALENDAR OF PUBLIC HEARING

CALENDAR OF PUBLIC HEARINGS

Those listed below appeared as witnesses at the United States International Trade Commission's hearing:

Subject:	THE CHANGING STRUCTURE OF THE GLOBAL LARGE CIVIL AIRCRAFT INDUSTRY AND MARKET: IMPLICATIONS FOR THE COMPETITIVENESS OF THE U.S. INDUSTRY
Inv. No.:	332-384
Date and Time.	March 17, 1998 - 9:30 a.m.

Sessions were held in connection with the investigation in the Main Hearing Room 101, 500 E Street, S.W., Washington, D.C.

ORGANIZATION AND WITNESS

Panel 1

Aina Holdings, Incorporated, Herndon, Virginia

Ian Massey, Chief Financial Officer, Airbus Industrie

Jonathan Schofield, Chairman of the Board, Airbus Industrie of North America

Panel 2

Rolls Royce North America, Incorporated, Arlington, Virginia

James Guyette, President and CEO, Rolls-Royce North America, Incorporated

T. Charles Coltman, Director of Strategic Planning, Rolls-Royce plc

-MORE-

ORGANIZATION AND WITNESS

Panel 3

The Boeing Company, Arlington, Virginia

Stanley Ebner, Senior Vice President, Washington D.C. Operations

Panel 4

International Association of Machinists and Aerospace Workers, Upper Marlboro, Maryland

Robert Thayer, General Vice President

Owen Herrnstadt, Director, International Department

-END-

APPENDIX D

GLOSSARY OF TERMS

GLOSSARY

ACTUATORS

A device that transforms hydraulic pressure or electrical energy into controllable motion.

AIRCRAFT UTILIZATION RATE

Average number of hours per day that aircraft are flown.

AIRFRAME

The assembled structural and aerodynamic components of an aircraft that support the different systems and subsystems integral to the vehicle.

AIRWORTHINESS

Aircraft airworthiness certification consists of inspection and approvals throughout the aircraft's service. The aircraft must meet design and production standards developed for the type and category of aircraft and must be maintained according to U.S. standards throughout its life.

APPLIED RESEARCH

The effort that (1) normally follows basic research, but may not be severable from the related basic research, (2) attempts to determine and exploit the potential of scientific discoveries or improvements in technology, materials, processes, methods, devices, or techniques, and (3) attempts to advance the state of the art. Applied research does not include efforts whose principal aim is design, development, or test of specific items or services to be considered for sale; these efforts are within the definition of the term development, defined below.

AVAILABLE SEAT KILOMETER (ASK)

One aircraft seat flown one kilometer. ASKs are a standard measure of airline capacity.

AVAILABLE SEAT MILES (ASM)

One aircraft seat flown one mile. ASMs are a standard measure of airline capacity.

AVIONICS

Aircraft instruments and systems related to flight navigation and control.

BASIC RESEARCH

Research that is directed toward the increase of knowledge in science. The primary aim of basic research is a fuller knowledge or understanding of the subject under study, rather than any practical application thereof.

BEYOND RIGHTS

Also known as fifth freedom rights, it allows an air carrier to transport passengers from one foreign country to another. See also “Five Freedoms” in Glossary.

BILATERAL AIRWORTHINESS AGREEMENT (BAA)

Bilateral agreements between the United States and foreign governments providing for reciprocal acceptance of airworthiness certification functions. These agreements are now being supplanted by Bilateral Aviation Safety Agreements.

BILATERAL AVIATION SAFETY AGREEMENT (BASA)

To facilitate the FAA's need to include additional aviation safety program areas in a bilateral agreement, the U.S. Government has now established a new format for bilateral agreements that separates U.S. policy and technical procedures. The new format, the BASAs, are replacing the existing Bilateral Airworthiness Agreements (BAA). In addition to meeting U.S. airworthiness requirements, products generally can only be imported from countries with whom FAA has concluded a Bilateral Airworthiness Agreement or a Bilateral Aviation Safety Agreement (BASA) with Implementation Procedures for Airworthiness. The national authority of that country must have issued an export certificate for that product.

CABOTAGE

Cabotage is the transport of passengers between any two points in the same country.

CHAEBOL

Large Korean industrial conglomerate.

CNC MACHINE

Computer numerical control (CNC) machines are controlled and operated by a dedicated computer, and the number of axes represents the number of motions a machine can perform. An increasing number of axes allows the machining of more complex part geometries in a single setup and diminishes the likelihood of error. The use of CNC machines also provides manufacturers with greater control over accuracy and quality, and reduces the space, time, and equipment necessary for production.

CODE-SHARING ARRANGEMENT

A code-sharing arrangement is an alliance between airlines whereby airlines share reservation computer codes, coordinate flight schedules, and allow single payments through either carrier for connecting flights. This facilitates faster, more efficient transfer of passengers to final destinations.

COMMONALITY

Commonality refers to the use of common features, parts, and systems in an LCA manufacturer’s aircraft that enables an airline to operate as homogenous a fleet as possible.

COMPOSITES

Composite materials combine two or more separate materials to take advantage of the materials' characteristics, which can be tailored to the needs of the user. For example, metal matrix composites combine a metal's ductility with the strength and stiffness of carbon fibers.

COMPUTATIONAL FLUID DYNAMICS (CFD)

CFD is a tool for predicting the aerodynamics and fluid dynamics of air as it flows around flight vehicles by solving a set of mathematical equations with a computer. Also known as "numerical aerodynamic simulation," CFD is used in aircraft research and development programs to improve the understanding of subsonic flow physics and as an aircraft design tool. CFD was originally developed in weapons laboratories to model phenomena of nuclear-bomb explosions. During the early 1960s, CFD was applied principally to aircraft structural analysis. Because of the relatively low speed of existing computers, the aircraft design process remained validated in wind tunnels, using models of aircraft from the 1950s through the early 1980s. With the advent of faster computers, especially supercomputers, CFD became a more viable design tool.

CORE TECHNOLOGY

Core technology refers to the technical processes and practical knowledge that are the primary requisites of production in a specific industry.

CROSS-CREW QUALIFICATION (CCQ)

Originally an Airbus term, CCQ enables a pilot to train for a new aircraft type with "difference training" instead of a new full type-rating training course, because the flight decks, handling characteristics, and operational characteristics of the involved aircraft are similar.

DERIVATIVE AIRCRAFT

A derivative aircraft is one based on a manufacturer's existing model to which fuselage sections have either been added or deleted, and in which changes to the engines and/or avionics may have been made.

DEVELOPMENT

The systematic use, under whatever name, of scientific and technical knowledge in the design, development, test, or evaluation of a potential new product or service (or of an improvement in an existing product or service) for the purpose of meeting specific performance requirements or objectives. Development includes the functions of design engineering, prototyping, and engineering testing. Development excludes subcontracted technical effort for the sole purpose of developing an additional source for an existing product; or development effort for manufacturing or production of materials, systems, processes, methods, equipment, tools, and techniques not intended for sale.

EMPENNAGE

The assembly of stabilizing and control surfaces at the tail of an aircraft.

FINANCIAL INDUSTRIAL GROUP (FIG)

Industry-led FIGs are loosely based on a central industrial enterprise and a group of associated companies that may or may not contribute to production of a single output, but generally have a central managing board. FIGs are meant to be transitional organizations to help industries regroup in the face of shrinking capital, orders, and government support.

FIRST-MOVER ADVANTAGE

First-mover advantage is characterized by economic structures in which there are a limited number of possible entrants, productivity gains through learning, or scale economies that confer cost or market share advantages to the first movers or entrants in a market. The risks and costs for first movers into a market include the typical risks of investing as well as the opportunity costs of alternative investments. In addition, first movers also face the added risk of the possible reactions of other potential entrants. That is to say, potential first entrants are faced with the risk of either lagging behind or entering simultaneously with other entrants into the market. The resulting costs in these cases are either the losses or reduced earnings from not entering the market first.

FLIGHT FREQUENCY

The number of flights in a given period of time that an airline supplies for a given route.

FIVE FREEDOMS

The five freedoms of air transport were a result of the Chicago Convention of 1944. They pertain to the right to (1) fly over another nation, (2) land in another nation without picking up or disembarking passengers, (3) disembark in another nation passengers that boarded in the carrier's home country, (4) carry passengers of another nation to the carrier's home country, and (5) carry passengers from one foreign country to another. In Open Skies agreements, "beyond rights" refer to fifth freedom traffic.

FLY-BY-WIRE CONTROL SYSTEM

Fly-by-wire refers to the use of computer-actuated electronic servo motors in place of hydraulic actuators used in moving an aircraft's control surfaces. This technology decreases weight in the aircraft through deletion of some/all of the hydraulic flight control systems/plumbing, and can create a computerized record of operation, which can be accessed by ground support crews either on the ground or while the aircraft is in flight. Commercial use of fly-by-wire first occurred with the Concorde.

FOREIGN SALES CORPORATIONS

The U.S. foreign sales corporation (FSC) program allows U.S. corporations to exempt a portion of their income derived from exports from U.S. income taxes. The exemption applies to receipts from exports that have at least 50 percent U.S. origin by market value.

FREE FLIGHT

Free flight is an air traffic management concept that allows pilots, under certain circumstances, to select their flight path and aircraft speed in real time utilizing GPS technology and data communications coupled with automated monitoring.

FREQUENCY

See "Flight Frequency."

FUSELAGE

The main body of an aircraft, cylindrical in shape. It contains the cockpit, main cabin, and cargo compartments.

GLOBAL SUPPORT NETWORK

An airline manufacturer establishes supply depots and support personnel in strategic locations around the world in a global support network to provide quick, efficient customer support in any location.

GLOBAL POSITIONING SYSTEM

Global positioning system (GPS) uses a constellation of satellites and radio signals to determine the position, velocity, and altitude of GPS-equipped aircraft.

HUB

An airport that serves as an airline's gateway for connecting flights to outlying "spoke" cities on its route system.

JIGS

Precisely built frameworks used in aligning aircraft structural parts and aluminum skin panels. A jig can be as much as a hundred feet long and taller than a two-story house.

LARGE CIVIL AIRCRAFT (LCA)

Traditionally, civil aircraft with more than 100 seats in the case of passenger aircraft, or more than 33,000 pounds in the case of cargo aircraft.

LAUNCH CUSTOMER

A launch customer is the first airline to place a firm order for a new model aircraft.

LEAD TIMES

The time between order placement and delivery of a product.

LOAD FACTOR

Percentage of available seat miles (or kilometers) occupied by paying passengers.

MEDIUM-SIZED AIRCRAFT

Term used by Asian nations to denote 100-seat aircraft.

NET ORDERS

Aircraft order cancellations are subtracted from initial "Gross" orders to provide "Net" orders. Cancellations are typically removed from the year the order was placed and not from the year the order was canceled.

NET PRESENT VALUE (NPV)

NPV is the sum of all cash flows discounted to the present time by the appropriate cost of capital. If a project has a positive NPV, then its cash flows are generating more than the required rate of return.

OFFSETS

The term “offsets” refers to concessions that are required by certain governments as a condition of purchasing defense or commercial products from foreign sources. Offsets may take various forms, including co-production, licensed production, subcontractor production, overseas investment, and/or technology transfers.

OPEN SKIES

Open Skies refers to bilateral air service agreements that allow unlimited access of airlines to signatories' domestic markets, code-sharing alliances, and the right to extend flights to third countries (beyond rights).

PART 23

FAA regulations pertaining to airworthiness standards for normal, utility, acrobatic, and commuter category airplanes.

REGIONAL AIRLINE

A regional airline is a short-haul scheduled carriers providing service between small- and medium-sized communities and the nation's hub airports. This service is primarily provided with turboprop aircraft with 19 to 70 seats, although some airlines operate small turbofan aircraft with 50 to 100 seats.

RESEARCH

Systematic study directed toward fuller scientific knowledge or understanding of the subject studied. Research is classified as either basic or applied to the objectives of the sponsoring agency.

RESEARCH AND DEVELOPMENT

Basic and applied research in the science and engineering and the design and development of prototypes and processes. This definition excludes quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, and other nontechnical activities or routine technical service.

REVENUE PASSENGER KILOMETER (RPK)

One revenue passenger transported one kilometer in revenue service. Revenue passenger kilometers are calculated by multiplying revenue aircraft kilometers flown during a flight stage by the number of revenue passengers carried on that flight stage.

REVENUE PASSENGER MILE (RPM)

One revenue passenger transported one mile in revenue service.

REVERSE ENGINEERING

Reverse engineering refers to the deconstruction of a finished product in order to determine how it was constructed by its manufacturer.

RISK-SHARING PARTNERSHIPS

Risk-sharing partners assume a portion of the financial risk of (aircraft) development and production and, in some cases, may act as though they were partially integrated into the LCA manufacturers.

SCOPE CLAUSES

Labor contract clauses that specify which pilots are allowed to fly aircraft owned/operated by an airline. Scope clauses are central to airlines' decisions on whether subsidiary feeder/commuter airline pilots are allowed to fly jet aircraft, i.e., regional jets.

SEAT-MILE COSTS

The costs involved with a single available seat mile. This cost is usually an average for an airline's fleet as a whole.

SHADOW CERTIFICATION

A certification process in which the FAA follows a foreign country's airworthiness authorities through their aircraft certification process in order to understand and evaluate capabilities in design, production, and airworthiness certification of civil aeronautical products and observe how FAA rules are applied.

"SOFT" LOANS

"Soft" loans may be construed as those with below-market terms, either through lower, preferential interest rates, unusual terms of repayment, or a combination of both.

SPECIAL USE AIRSPACE

Special Use Airspace refers to airspace of defined dimensions wherein activities must be confined because of its nature, or wherein limitations are imposed upon aircraft operations that are not a part of those activities, or both.

STAGE 2

Term used to describe jets that meet certain noise parameters on takeoff and landing.

STAGE 3

More stringent noise parameters than Stage 2 for takeoff and landing.

STAGE LENGTH

Average miles per flight segment.

SUBASSEMBLY

An assembled unit designed to be incorporated with other units in a finished product. Examples of aircraft subassemblies include wings, landing gear, flight control systems, and the main passenger door.

TURBOFAN

A type of jet engine in which a certain portion of the engine's airflow bypasses the combustion chamber.

TURBOPROP

A type of engine that uses a jet engine to turn a propeller. Turboprops are often used on regional and business aircraft because of their relative efficiency at speeds slower than, and altitudes lower than, those of a typical jet.

TYPE-RATING (PILOT)

Pilot type-rating is a certification allowing a pilot to fly a specific make and basic model of aircraft, including modifications thereto that do not change the aircraft's handling or flight characteristics. Pilots can only fly aircraft for which they have a pilot type-rating.

ULTRA-HIGH CAPACITY AIRCRAFT

Any aircraft with a capacity exceeding 500 seats.

WIND TUNNEL

A ground test facility used to test flight characteristics of an aircraft by directing a controlled stream of air around a scale model and measuring the results with attached instrumentation. Wind tunnels test aerodynamic forces such as lift, drag, and side forces and consist of an enclosed passage through which a test gas is driven by a fan or some other type of drive system.

APPENDIX E

IMPLEMENTATION OF THE 1992 U.S.-EU LARGE CIVIL AIRCRAFT AGREEMENT

Implementation of the 1992 U.S.-EU Large Civil Aircraft Agreement

Views of Signatories

Although the 1992 Agreement addressed many of the issues of interest to the United States and the European Union (EU) relative to government support of the large civil aircraft (LCA) industry, certain provisions of the agreement are the subject of ongoing disputes. The United States and the EU continue to disagree on the definition of direct and indirect government subsidies (articles 3 and 5). The two signatories define the term "production support" (specific to direct subsidies) differently, and have adopted widely divergent interpretations of and methodologies to assess the level of indirect government support.[803] The EU has expressed frustration with the lack of U.S. acknowledgment of perceived spillover effects from military research and development, which the EU estimates provides the U.S. industry with an 8- to 15-percent benefit.[804] Airbus claims that such expenditures reduce Boeing's annual R&D costs.[805] Boeing, however, claims that "there is no basis for assuming or concluding that there is any transferability," or that military operations help the commercial sector in any meaningful way.[806]

Both sides have also expressed dissatisfaction with article 8 of the agreement, which addresses transparency and data reporting requirements.[807] According to Airbus, the United States has not been fully responsive to European transparency suggestions.[808] The EC believes that the United States will eventually answer its request for greater transparency, but the form and content of the response may not be adequate.[809] Boeing maintains, however, that there is little to no technology sharing between its civil and military sectors because such technologies are incompatible.[810] The

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[803] *International Trade: Long-Term Viability of U.S.-European Union Aircraft Agreement Uncertain*, Government Accounting Office (GAO), Dec. 19, 1994, found at Internet address http://frwebgate.access.gpo.gov/cgi-bin/ useftp.cgi?IPaddress=wais.access.gpo.gov&filename= gg95045.txt&directory=/diskb/wais/data/gaop. 38, retrieved Aug. 25, 1997, pp. 17-23.

[804] European Commission official, interview with USITC staff, Brussels, Mar. 30, 1998.

[805] In the area of indirect support, Airbus is seeking 1) revisions to the identifiable benefit concept, 2) opening of U.S. Government-funded R&D programs to foreign bidding, 3) reinstatement of royalties for use of U.S. Government-funded R&D, and 4) establishment of a discipline applicable for disclosure of embargoed programs. Airbus Industrie official, interview with USITC staff, Apr. 7, 1998.

[806] U.S. International Trade Commission (USITC), investigation No. 332-384, *The Changing Structure of the Global Large Civil Aircraft Industry and Market: Implications for the Competitiveness of the U.S. Industry*, transcript of the hearing on Mar. 17, 1998, p. 93.

[807] GAO, *International Trade*, p. 25.

[808] For improved transparency, Airbus would like to see 1) disclosure of R&D programs at launch, 2) early dissemination of R&D results, 3) disclosure of interim results, 4) disclosure of both R&D successes and failures, 5) declarations for each industry/government cooperative program, and 6) declarations of dual-use military R&D programs. Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[809] European Commission official, interview with USITC staff, Brussels, Mar. 30, 1998.

[810] USITC, transcript of the hearing for investigation No. 332-384, , pp. 95-96.

improved data transparency expected from the Airbus restructuring[811] could help to alleviate U.S. transparency concerns regarding Airbus financial data.

Although both parties have expressed interest in attracting more signatories to the 1992 Agreement, at this time there appears to be little support among nonsignatories to bring the bilateral agreement into the World Trade Organization.[812] The EC has indicated that China and Russia would be potentially important signatories, and that stricter rules should be applied to Canada and Brazil because of their competitive aircraft industries.[813] Airbus has also expressed its support for multilateralization to establish more effective disciplines on indirect supports and improved transparency.[814] Boeing, however, is less concerned about multilateralizing the 1992 Agreement, and believes the agreement may become less important if Airbus adopts a more market-oriented system with its restructuring program. According to Boeing, the agreement as well as any government support should be ended, in part because Airbus is a mature, thriving aircraft company.[815]

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[811] European industry officials, interview with USITC staff, Brussels, Mar. 30, 1998.

[812] "Brittan Says EU Wants to Reopen Aircraft Subsidies Deal with U.S," May 9, 1997, *Inside U.S. Trade*, found at Internet address http://www.insidetrade.com/sec-cgi/as_web.exe?SEC_IT1997+D+1260079, retrieved Aug. 25, 1997.

[813] European Commission official, interview with USITC staff, Brussels, Mar. 30, 1998.

[814] Airbus Industrie official, interview with USITC staff, Toulouse, France, Apr. 7, 1998.

[815] Boeing official, interview by USITC staff, Seattle, Feb. 11, 1998.

AGREEMENT
BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND THE EUROPEAN ECONOMIC COMMUNITY
CONCERNING THE APPLICATION OF THE GATT AGREEMENT
ON TRADE IN CIVIL AIRCRAFT
ON TRADE IN LARGE CIVIL AIRCRAFT

THE GOVERNMENT OF THE UNITED STATES OF AMERICA, hereinafter referred to as "the US",

and

THE EUROPEAN ECONOMIC COMMUNITY, hereinafter referred to as "the Community",

RECOGNIZING the need to promote a more favourable environment for international trade in large civil aircraft and to reduce trade tensions in the area;

RECOGNIZING that the disciplines in tie GATT Agreement on Trade in Civil Aircraft should be strengthened with a view to progressively reducing the role of government support;

RECALLING the principles and objectives agreed upon by representatives of the US and of the Community at their meeting held in London on 27 October 1987;

IN PURSUIT OF their common goal of preventing trade distortions resulting from direct or indirect government support for the development and production of large civil aircraft and of introducing greater disciplines on such support and of encouraging the adoption of such disciplines multilaterally within the GATT,

NOTING their intention to act without prejudice to their rights and obligations under the GATT and under other multilateral agreements negotiated under the auspices of the GATT,

HAVE AGREED AS FOLLOWS:

ARTICLE 1
Government-Directed Procurement,
Mandatory Sub-contracts and Inducements

With respect to issues concerning Article 4 of the GATT Agreement on Trade in Civil Aircraft (hereinafter referred to as the "Aircraft Agreement"), the Parties agree to act in conformity with the interpretative note to Article 4 of the Aircraft Agreement contained in Annex I of this Agreement.

ARTICLE 2
Prior Government Commitments

Government support to current large civil aircraft programmes, committed prior to the date of entry into force of this Agreement, is not subject to the provisions of this Agreement except as otherwise provided below. The terms and conditions on which such support is granted shall not be modified in such a manner as to render it more favourable to the recipients; however, de minimis modifications shall not be deemed inconsistent with this provision.

ARTICLE 3
Production Support

As of entry into force of this Agreement, the Parties shall not grant direct government support other than what has already been firmly committed for the production of large civil aircraft. This prohibition shall apply both to existing and to future programmes.

ARTICLE 4
Development Support

4.1. Governments shall provide support for the development of a new large civil aircraft programme only where a critical project appraisal, based on conservative assumptions, has established that there is a reasonable expectation of recoupment, within 17 years from the date of first disbursement of such support, of all costs as defined in Article 6(2) of the Aircraft Agreement, including repayment of government supports on the terms and conditions specified below.

4.2. As of entry into force of this Agreement, direct government support committed by a party for the development of a new large civil aircraft programme or derivative shall not exceed:

> (a) 25 per cent of that programme's total development cost as estimated at the time of commitment (or of actual development costs, whichever is lower); royalty payments on this tranche shall be set at the time of commitment of the development support so as to repay this support at an interest rate no less than the cost of borrowing to the government within, no more than 17 years of first disbursement, plus
>
> (b) 8 per cent of that programme's total development cost as estimated at the time of commitment (or of actual development costs, whichever is lower); royalty payments on this tranche shall be set at the time of commitment of the development support so as to repay such support at an interest rate no less than the cost of borrowing to the government plus 1 percent within no more than 17 years of first disbursement.

These calculations shall be made on the basis of the forecast of aircraft deliveries in the critical project appraisal.

4.3. Royalty payments per aircraft shall be calculated at the time of commitment of the development support to be repaid on the following basis:

(a) 20 per cent of aggregate payments calculated in accordance with Article 4.2. are payable on the basis of the delivery of a number of aircraft corresponding to 40 percent of forecast deliveries;

(b) 70 per cent of aggregate payments calculated in accordance with Article 4.2. are payable on the basis of the delivery of a number of aircraft corresponding to 85 percent of forecast deliveries.

ARTICLE 5
Indirect Government Support

5.1. The Parties shall take such action as is necessary to ensure that indirect government support neither confers unfair advantage upon manufacturers of large civil aircraft benefiting from such support nor leads to distortions in international trade in large civil aircraft.

5.2. As of entry into force of the Agreement, identifiable benefits to the development or production of any of the products covered by this Agreement, net of recoupment, derived from indirect support shall not exceed in any one year:

(a) 3 per cent of the annual commercial turnover of the civil aircraft industry in the Party concerned for the products covered by this Agreement, or

(b) 4 per cent of the annual commercial turnover of any one firm in the Party concerned for the products covered by this Agreement.

5.3. Benefits from indirect support shall be deemed to arise when there is an identifiable reduction in costs of large civil aircraft resulting from government-funded research and development in the aeronautical area performed after the entry into force of this Agreement.

Where it can be demonstrated that the results of research and development have been made available on a nondiscriminatory basis to large civil aircraft manufacturers of the Parties, benefits deriving from such technologies shall be excluded from the calculation in Article 5.2.
However, identifiable benefits may result when large civil aircraft manufacturers are responsible for, or have early access to, the conduct or results of such research.

lf a Party has reason to believe that other indirect supports provided by a government are resulting in identifiable reductions in the costs of large civil aircraft, the Parties shall consult with a view towards quantifying such reductions and including them in the calculation described above.

Benefits from indirect support resulting from the technology obtained through government-funded research and development or through other government programmes shall normally be calculated in terms of the reduction in the cost of research and development and in the reduction in the cost of the production equipment or production process technology.

ARTICLE 6
General Purpose Loans

The Parties shall assume no liability for specific loans that aircraft manufacturers make or make available, through direct loans, guarantees, or otherwise, to airlines, other than through official export credit financing consistent with the Large Aircraft Sector Understanding of the OECD Understanding on Official Export Financing.

ARTICLE 7
Equity Infusions

Equity infusions are excluded from the scope of this Agreement. Equity infusions will not, however, be provided in such a manner as to undermine the disciplines in the Agreement.

ARTICLE 8
Transparency

8.1. To the extent necessary to ensure effective implementation of this Agreement, the Parties shall exchange on a regular, systematic basis, all public information of a kind governments make available to their respective national elected assemblies relating to matters covered by this Agreement and its annexes. Such public information will include at minimum the total amount of government support for new development projects and its share of total development costs, aggregate data on disbursements and repayments relating to direct government supports for commercial aircraft programmes, the annual commercial turnovers of the civil aircraft industry as specified in Article 8.5(b) and the aggregate amounts of identifiable indirect benefits received by large civil aircraft manufacturers.

8.2. Furthermore, with regard to prior government commitments for large civil aircraft programmes described in Article 2, a complete list of such commitments by the Parties to this Agreement already disbursed or committed shall be separately provided, including information on the type of repayment obligation and the planned period of repayment. Annual disbursements and repayments relating to these programmes on an aggregate basis shall also be notified to the other Party for each government providing these supports. In addition, a Party shall notify the other Party to this Agreement of any changes which render the terms and conditions of such support commitments more favourable to the recipient, including: changes in the repayment period, failure to repay the support or reduction of the scheduled repayments.

8.3. Furthermore with regard to f uture large civil aircraft programmes, Parties shall provide, at the time of government commitment, the following specific information in relation to development support for each of the governments providing such support:

- the total amount of government support;
- the share of government support as a percentage of estimated total development cost;
- the anticipated return to the government;
- the planned period of repayment of government support; and
- the forecast number of planes on which the calculations made in accordance with Article 4.2 are based.

8.4. In the course of the consultations provided for under Article 11, the Parties shall exchange information on government commitments and support for each of the governments providing such support, including, but not limited to :

- any changes which render the terms and conditions more favourable to the Recipients including changes in the repayment period, failure to repay the support or reduction of the scheduled repayments; and
- annual disbursements and repayments on a per programme basis for new programmes launched in accordance with Article 4. Such information will be provided at the first regular consultation taking place at least twelve months after the end of the year in which the disbursements and repayments are made.

8.5. In the course of consultations under Article 11,

(a) the Parties will, on an annual basis, provide information on new government-funded research and development undertaken or initiated during the previous year and on ongoing research and development projects in the aeronautical area, including per programme details on those projects in which large civil aircraft manufacturers participate. This shall include information on the area of activity and the amount of government funding for such projects:

(b) The Parties will provide information on identifiable benefits derived from indirect, supports for each large civil aircraft programme.

This will include recoupment per programme received from large civil aircraft manufacturers. The following specific information will be provided on an annual basis for each of the governments providing such support:

1) the annual commercial turnover of the civil aircraft industry in the Party concerned in relation to products covered by the Agreement;

2) the annual commercial turnover in relation to products covered by the Agreement of each firm in the Party concerned which manufactures products covered by the Agreement; and

3) the total amount of indirect benefits as defined in Article 5.2. for the civil aircraft industry in relation to the products covered by the Agreement and for each firm involved in the manufacture of such products.

8.6. If a Party considers that additional information directly relevant to the implementation of the provisions of this Agreement is necessary, such information will be provided upon duly motivated request.

8.7. The Parties shall, upon duly motivated request, provide at the tine of commitment of new development support non-proprietary information on the critical project appraisal in so far as this relates to the provisions of Article 4.1.

8.8. Any information not in the public domain, which a Party may provide, shall at the request of the Party providing the information, be considered as proprietary. A recipient government shall take all measures necessary to ensure that information thus designated not be disclosed to anyone outside that government even after expiry or termination of the present Agreement. In addition, proprietary information shall not be used in possible trade disputes except for the purposes of confidential internal government discussion and decisions in relation to the implementation of the Agreement.

8.9. The Parties shall, unless otherwise indicated, exchange the information specified above on an annual basis. Any disagreement concerning information to be provided pursuant to this Article shall be resolved through consultations under Article 11.

8.10. The Parties shall provide information on new infusions of equity or changes in equity positions by governments into firms engaged in civil aircraft production, including the amount and type of equity provided,

8.11. The Parties will encourage firms engaged in the manufacture of large civil aircraft to increase the public disclosure of disaggregated financial results of their civil aircraft operations through the separation of reporting on military and civilian aircraft operations and the adoption of lines of business financial reporting. These disaggregated financial results would at a minimum be expected to include information on sources and uses of funds including specific information on revenue, operating income, net assets, capital investment and government equity infusions.

8.12. Nothing in this Agreement shall be construed to require any contracting Party to furnish any information the disclosure of which it considers contrary to its essential security interests.

ARTICLE 9
Exceptional circumstances

9.1. Where, as a result of an unforeseen, exceptional situation, the survival of a significant proportion of the civil aircraft manufacturing activities in one of the Parties (1) and the continued financial viability of the company or the division of a company responsible for such civil aircraft manufacture are put in jeopardy, that Party may derogate temporarily from the disciplines laid down in this Agreement. In this context, the disaggregated financial results of civil aircraft operations will be reported publicly by that company or division (2). This derogation may not be invoked, however, with regard to the disciplines applying to the launch of new civil aircraft programmes as specified in Article 4.

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(1) For the purposes of this paragraph, "Parties" shall be deemed to include any of the individual Member States of the Community.

(2) These disaggregated financial results would at a minimum include information on sources and uses of funds including specific information on revenue, operating income, net assets, capital investment and government equity infusions.

9.2. The Party concerned shall provide notice of its intentions to the other Party and an opportunity for prior consultations unless it is prevented from, doing so for legal reasons and shall in any event notify the other Party immediately of its reasons for invoking this Article and fully disclose the specific measures which it has taken, including the amount and nature of the measures and their expected duration.

9.3 Specific measures taken by a Party in accordance with this Article shall:

(a) be limited in scope and duration to the extent strictly necessary to remedy the difficulties referred to in paragraph 1;

(b) be designed to return as quickly as possible the beneficiary company to commercial viability;

(c) take due account of the possible implications for other large civil aircraft manufacturers and shall avoid depressing prices on the world market for civil aircraft by the manufacture of inventory for which no firm order exists.

9.4. If, after consultations pursuant to Article 11, a Party determines that the action taken under this Article significantly undermines the objectives of this Agreement, it shall have the right to suspend some or all of the provisions of this Agreement or to terminate it within 15 days of the conclusion of consultations.

ARTICLE 10

Avoidance of Trade Conflicts and Litigation

10.1. The Parties shall seek to avoid any trade conflict on matters covered by the present Agreement (1) .

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(1) Action with regard to "matters covered by the present Agreement" refers to trade actions relating to direct and indirect government support as defined by this Agreement. It does not include actions relating to dumping, intellectual property protection, or anti-trust or competition laws.

10.2. The Parties will not self-initiate action under their national trade laws with regard to government supports granted in conformity with this Agreement for as long as this Agreement is in force. However, nothing in this paragraph shall prevent a Party from abrogating this Agreement on grounds of non-compliance by the other Party.

10.3. In order to avoid trade conflict, the Parties will strongly encourage private parties to request the use of the provisions of Article 11 to resolve any disputes on matters covered by this Agreement. If, however, private petitioners request that action be taken under national laws on matters covered by this Agreement, the petitioners' government will immediately inform the other Party and offer to enter into consultations in accordance with Article 11. The Party against whom such action is brought shall have the right either to suspend the application of some or all the provisions of the present Agreement or to terminate the Agreement 15 days after the conclusion of consultations.

10.4. In the conduct of any investigations of trade allegations concerning products covered by this Agreement that have been initiated under national trade laws as the result of private petitions, the Parties shall, consistent with their law, take account of representations concerning compliance with the terms of this Agreement.

ARTICLE 11

Consultations

11.1. The Parties shall consult regularly and, in any case, at least twice a year, to ensure the correct functioning of the Agreement.

11.2. A Party may request consultations on any development related to the functioning of the present Agreement. Such consultations shall be held not later than 30 days following the date on which the request is received.

11.3. The Parties agree to seek to resolve any disputes within three months of the date of the initial request for consultations. Consultations will not be deemed to be concluded for the purposes of Articles 8 and 9 before this three-month period has expired.

ARTICLE 12
GATT Agreement on Trade in Civil Aircraft

12.1. The Parties shall propose jointly to other signatories of the Aircraft Agreement referred to in Article 1 that disciplines along the lines of those laid down in the present Agreement and the interpretative note given in Annex I be incorporated into the Aircraft Agreement. The Parties shall also propose that the improved dispute settlement provisions agreed in the Uruguay Round be used to resolve any dispute arising out of the implementation of the new Aircraft Agreement.

12.2. The Parties shall make their utmost efforts to ensure that these or similar disciplines are incorporated into the Aircraft Agreement or adopted by key signatories at the earliest possible date, and also to expand the coverage of the disciplines provided by this Agreement to all of the products covered in the Aircraft Agreement.

12.3. If multilateralization has not been achieved in one year, the Parties shall review the question of the continued application of this bilateral Agreement.

ARTICLE 13
Final Provisions

13.1. This Agreement shall enter into force on the date of its acceptance by both Parties.

13.2. This Agreement may be amended by mutual consent of the Parties to take into account any new situation which. may arise including possible amendments to the Aircraft Agreement.

13.3. One year after the entry into force of this Agreement, either party may withdraw from the Agreement. If a Party wishes to withdraw from the present Agreement, it shall notify the other Party in writing of its intentions. The withdrawal shall take effect 12 months after the date on which the notification was received.

ANNEX I

INTERPRETATION OF ARTICLE 4 OF THE GATT AGREEMENT ON TRADE IN CIVIL AIRCRAFT BY SIGNATORIES OF THE AGREEMENT

Article 4 of the GATT Agreement on Trade in Civil Aircraft (hereinafter referred to as "the Agreement") deals with three specific issues:

- government-directed procurement (paragraph 2):

- mandatory sub-contracts (paragraph 3);

- inducements (paragraph 4).

Article 4.1.

Paragraph 4.1. states the general principle, applicable throughout Article 4. that purchasers of civil aircraft (1) should be free to select supplies on the basis of commercial and technological factors.

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(1) For the purpose of this Annex, "civil aircraft" is defined as in Article of the GATT Agreement on Trade in Civil Aircraft.

Article 4.2.
(Government-Directed Procurement)

This paragraph states that "signatories shall not require airlines, aircraft manufacturers, or other entities engaged in the purchase of civil aircraft, nor exert unreasonable pressure on them, to procure civil aircraft from any particular source, which would create discrimination against suppliers from any signatory".

This means that signatories must abstain from imposing preference policies in favour of or against the suppliers of one or more signatories,

Unreasonable government pressure relating to the selection of suppliers by airlines, aircraft manufacturers or other entities engaged in the purchase of civil aircraft ("purchasers") is also prohibited. "Unreasonable pressure" is any action favouring products or suppliers or which influences procurement decisions in a manner which creates discrimination against suppliers from any other signatory.

The signatories agree that the following are examples of practices which are not considered as exerting unreasonable pressure;

- the participation of government or former government representatives on the boards of wholly or partly government-owned purchasers, but only if they act in the best commercial interest of the purchaser concerned and do not influence procurement decisions in a manner which creates discrimination against suppliers from any other signatory;

- government decisions concerning safety and environmental considerations.

Article 4.3.
(Mandatory Subcontracts)

The first sentence states that "signatories agree that the purchase of products covered by the Agreement should be made only on a competitive price, quality and delivery basis". This means that signatories will not intervene to obtain favored treatment for particular firms and that they will not interfere with the selection of vendors in a situation where vendors of different signatories are competing.

By emphasizing that the only factors which should be involved in purchase decisions are price, quality and delivery terms, the signatories agree that Article 4 3. does not permit Government-mandated offsets. Further, they will not require that other factors, such as subcontracting, be made a condition or consideration of sale. Specifically, a signatory may not require that a vendor must provide offset, specific types or volumes of business opportunities, or other types of industrial compensation.

Signatories shall not therefore impose conditions requiring subcontractors or suppliers to be of a particular national origin.

The second sentence of this paragraph states that "in conjunction with the approval or awarding of procurement contracts for products covered by this Agreement a signatory may require that its qualified firms be provided with access to business opportunities on a competitive basis and on terms no less favourable than those available to the firms of other signatories."

This means that a signatory may require that the manufacturer not discriminate against the signatory's qualified firms with respect to any bid opportunities and to the evaluation of any competitive bids made by those firms.

Article 4.4.
(Inducements)

This paragraph states that "signatories agree to avoid attaching inducements of any kind to the sale or purchase of civil aircraft from any particular source which would create discrimination against suppliers from any signatory".

This means that signatories shall refrain from the use of negative or positive linkages between the sale or purchase of civil aircraft and other government decisions or policies which might influence such sale or purchase whenever there is a competition between suppliers of signatories.
The following is an agreed illustrative, non-exhaustive list of such prohibited inducements:

- rights and restrictions relating to the airline industry, such as landing or route rights;

- general economic programmes and policies. such as import policies, measures aiming at changes in bilateral trade imbalances, policies on alien workers or debt rescheduling;

- development assistance programmes and policies, such as grant aid, loans and infrastructure financing; it is understood that the use of such assistance for the purchase of civil aircraft does not fall under this category to the extent that the granting of these funds is not conditional on such purchase taking place;

- defence and national security policies and programmes.

Without prejudice to Article 4.3., this also means that signatories shall not intervene in any way, nor exert any direct or indirect pressure on other governments or any entity involved in procurement decisions, including the establishment of any link of a negative or positive character between decisions concerning the procurement of civil aircraft and any other issue or action in any other area which might affect the interest of the importing country.

Articles 4.2. and 4.4.
(Political Representations)

All participants of signatories in the domestic political decision-making process shall not take any action. including, but not limited to, political representations, pressure or inducements to other governments or foreign airlines, which would be contrary to Article 4 as interpreted in this Annex. Signatories shall draw he participants' attention to this interpretation of Article 4 and shall also use their best efforts to assure that the participants do not take such action.

ANNEX II

For the purposes of the present Agreement, the following definitions shall apply:

1. "large civil aircraft": with regard to such aircraft produced in the US by existing manufacturers of large civil aircraft and in the European cmmunity by the Airbus consortium, or their successor entities, all aircraft, as defined in Article 1 of the GATT Agreement on Trade in Civil Aircraft, except engines as defined in Article 1.1(b) thereof, that are designed for passenger or cargo transportation and have 100 or more passenger seats or its equivalent in cargo configuration.

2. "derivative": an aircraft model the major design elements of which are derived from a prior aircraft model.

3. "total development cost", as referred to in Article 4.2.: the following cost items, incurred prior to the date of certification, are those which may be taken into account in assessing the "total development cost" referred to in Article 4.2.:

- preliminary design
- engineering design
- wind-tunnel, structural, system and laboratory tests
- engineering simulators
- equipment development work, except for work directly financed by equipment and engine manufacturers
- flight tests, including associated ground support, and analysis necessary to obtain certification
- documentation required for certification
- the cost of manufacture of prototypes and test aircraft, including spares and such modifications as may be necessary to obtain certification, less the estimated fair market value of flight aircraft after refurbishment
- jigs and tools, except machine tools, for use on specific programmes,

4. "production": all manufacturing, marketing and sales activities other than those described under point 3 with the exception of official export credit financing consistent with the Large Aircraft Sector Understanding of the OECD Understanding on Official Export Financing.

5. "indirect government support": financial support provided by a government or by any public body within the territory of a Party for aeronautical applications, including research and development, demonstration projects and development of military aircraft, which provide an identifiable benefit to the development or production of one or more specific large civil aircraft programmes.

6. "direct government support": any financial support provided by a government or by any public body within the territory of a Party which is provided:

1) for specific large civil aircraft programs or derivatives or
2) to specific companies to the extent that large civil aircraft programmes or derivatives directly benefit.

7. "royalty payment": repayment of a certain predetermined amount of development support per aircraft delivered.

APPENDIX F

FIGURES OF U.S., WEST EUROPEAN, AND RUSSIAN LARGE CIVIL AIRCRAFT

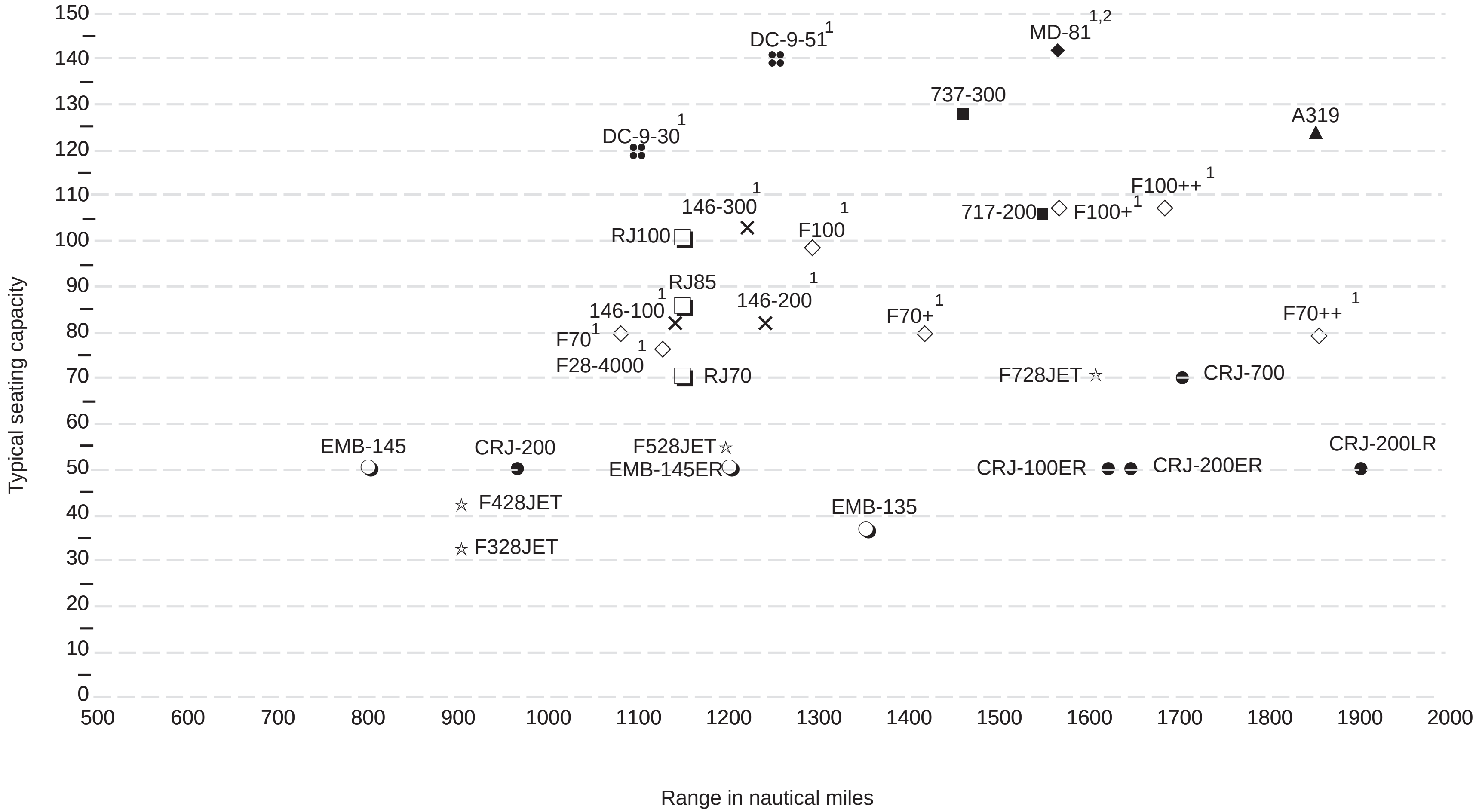
Figures of U.S., West European, and Russian large civil aircraft

Symbols used on the following charts:

Airbus	▲
AVRO	❏
British Aerospace	X
Boeing	■
Canadair	●
Douglas	⁘
Embraer	◐
Ilyushin	▦
Lockheed	○
McDonnell Douglas	◆
Tupolev	◑
Fokker	◇
Fairchild-Dornier	☆

Note.—The suffix "+" on Fokker aircraft denotes alternate engine options.

Figure F-1
Western turbofan aircraft with a range not exceeding 2,000 nautical miles



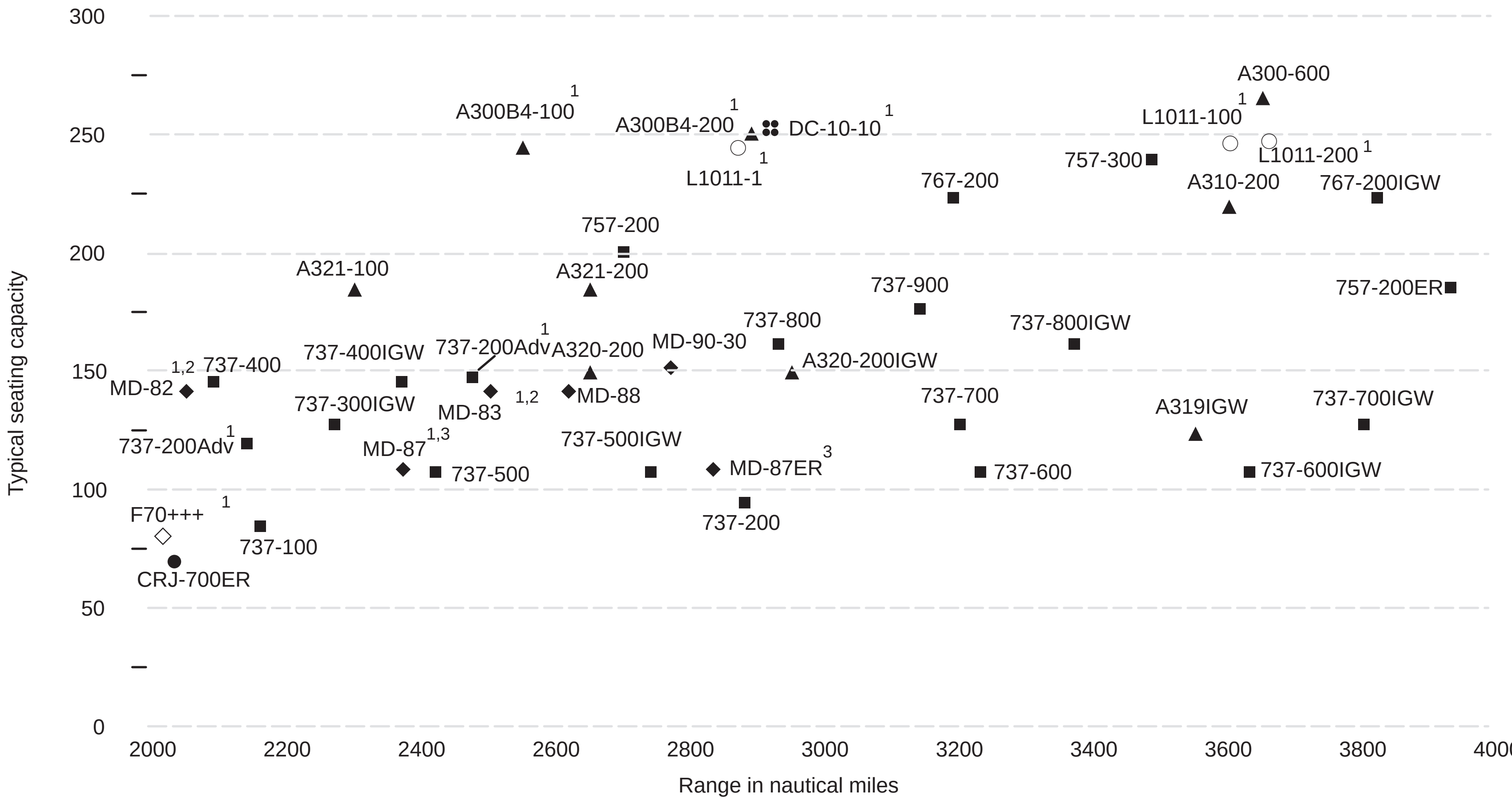
[1] No longer in production.

[2] Range with 155 passengers.

Note.—31 aircraft represented with an average seating capacity of 81.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft*, *1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

Figure F-2
Western turbofan aircraft with a range over 2,000 but not exceeding 4,000 nautical miles



[1] No longer in production.

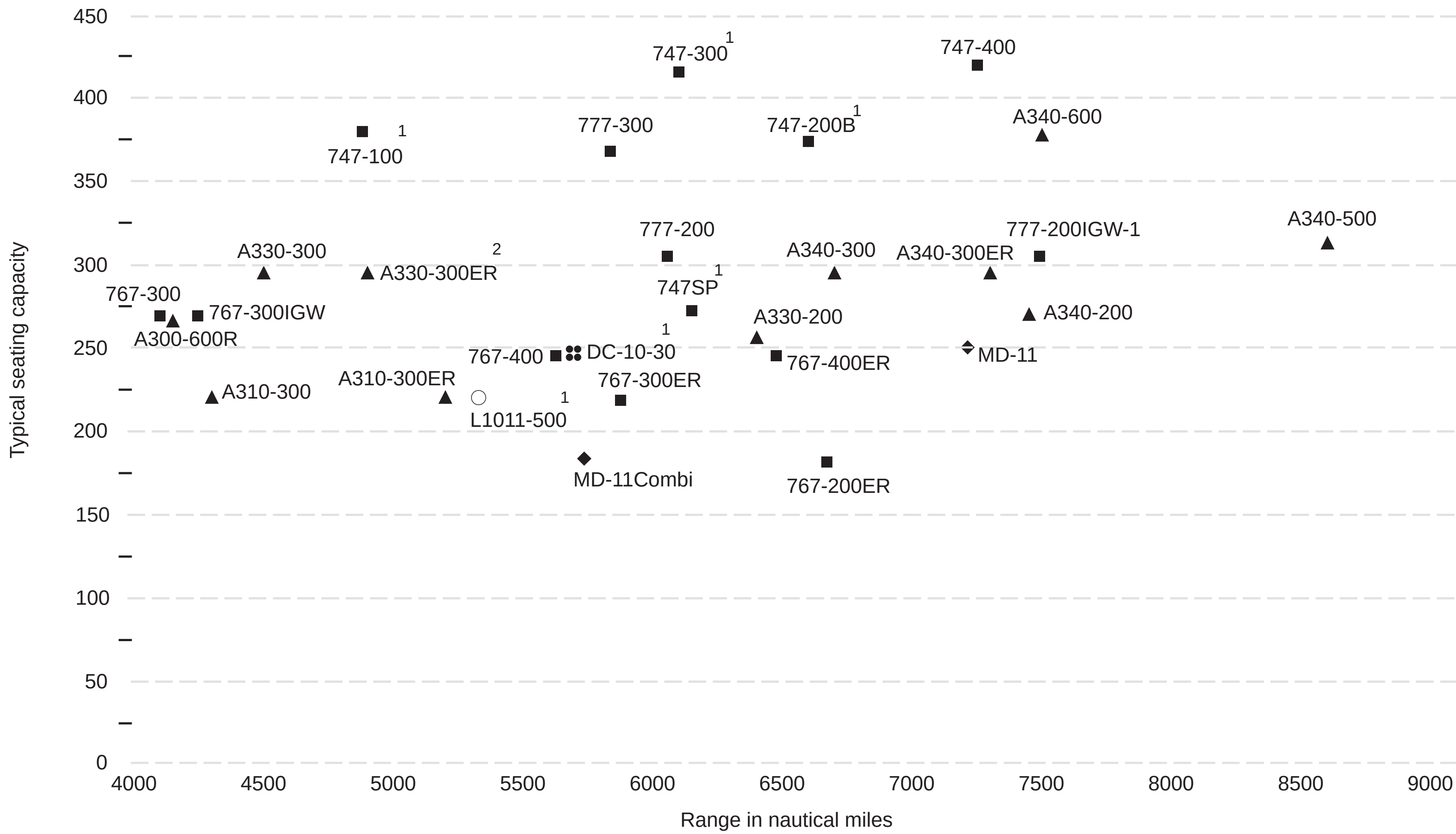
[2] Range with 155 passengers.

[3] Range with 130 passengers.

Note.—42 aircraft represented with an average seating capacity of 163.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft*, *1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

Figure F-3
Western turbofan aircraft with a range over 4,000 nautical miles



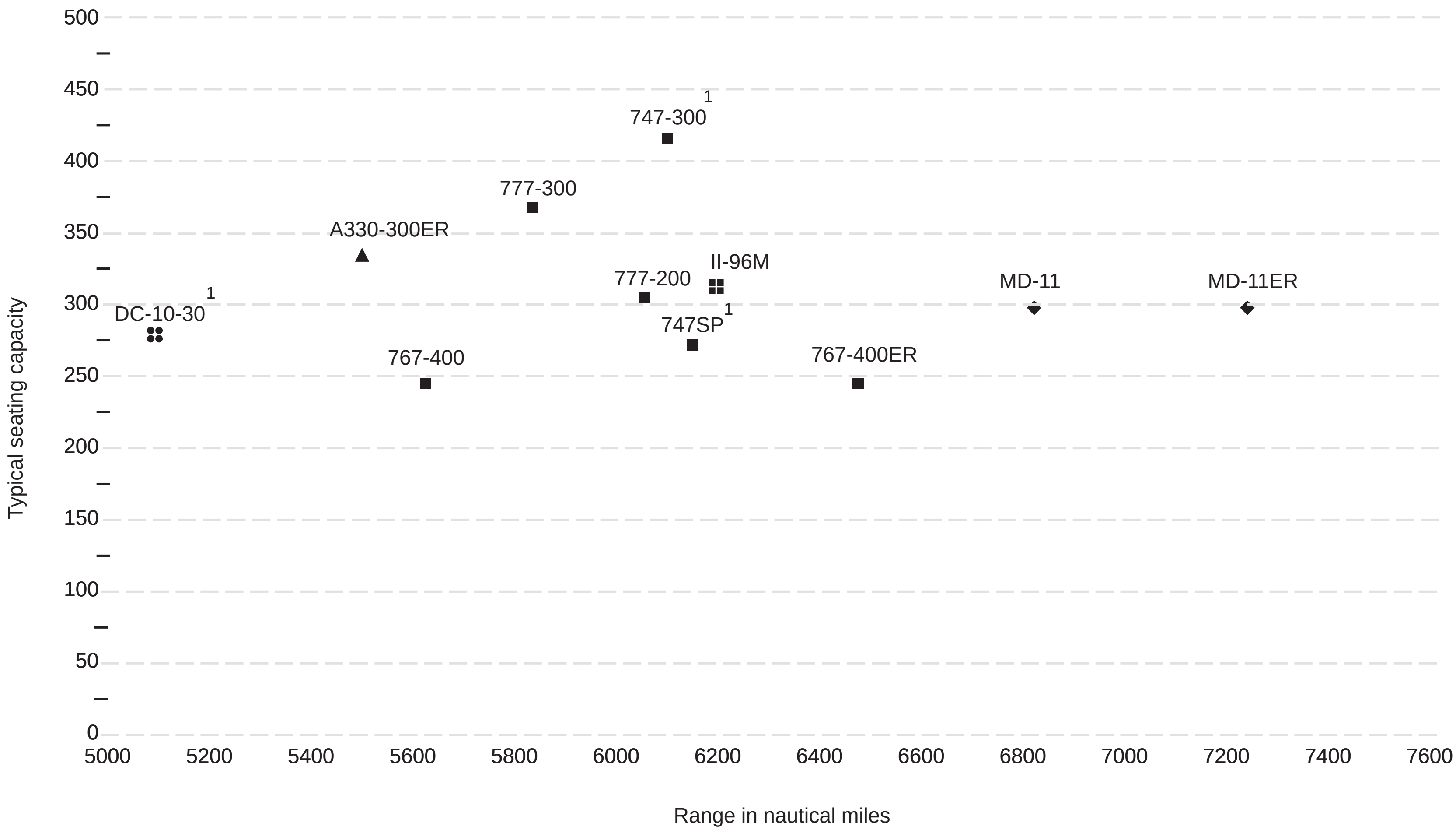
[1] No longer in production.

[2] Range with 335 passengers.

Note.—29 aircraft represented with an average seating capacity of 288.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft, 1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

Figure F-4
Ilyushin Il-96M and similar Western aircraft

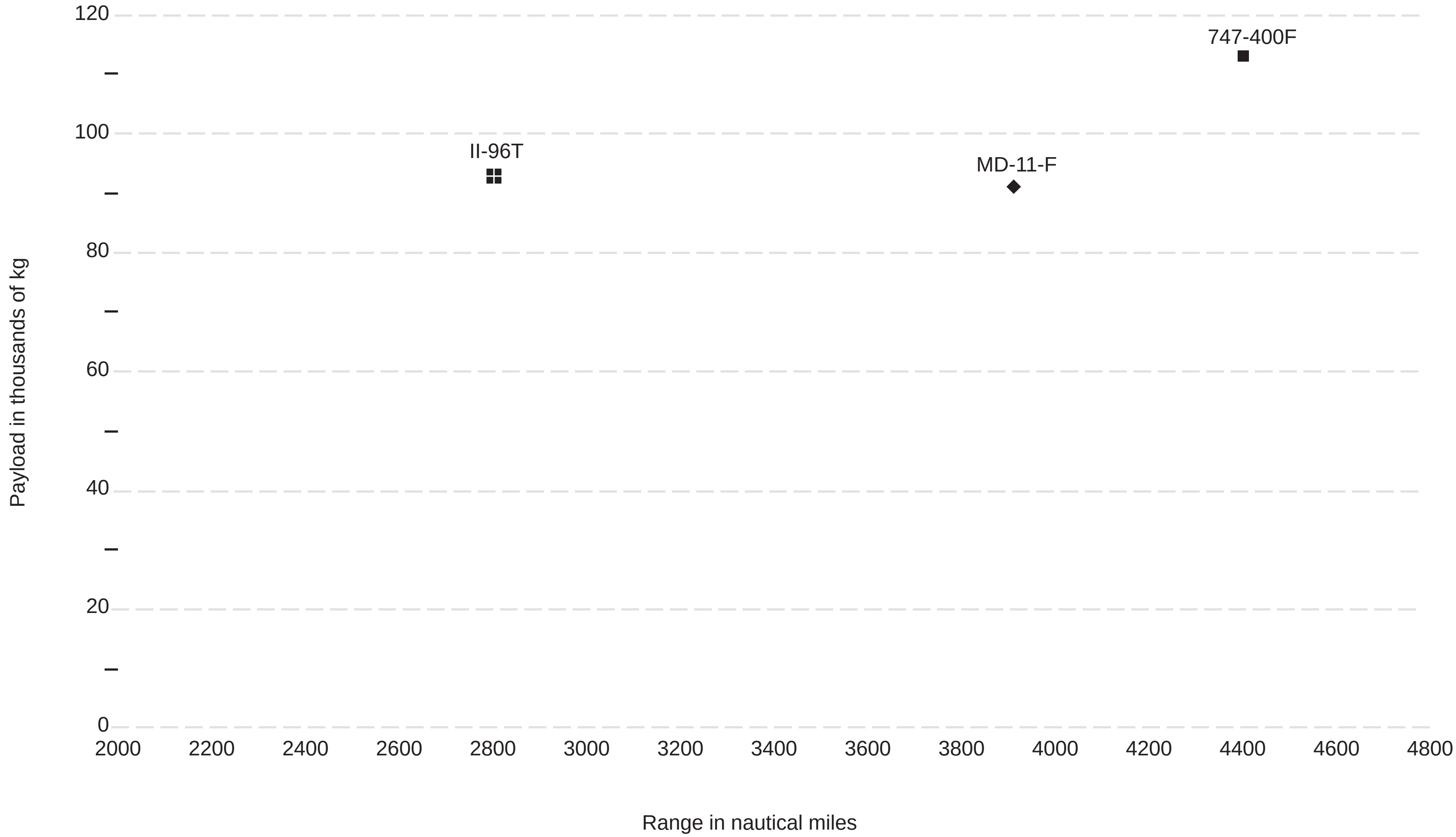


[1] No longer in production.

Note.—11 aircraft represented with an average seating capacity of 306.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft*, *1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

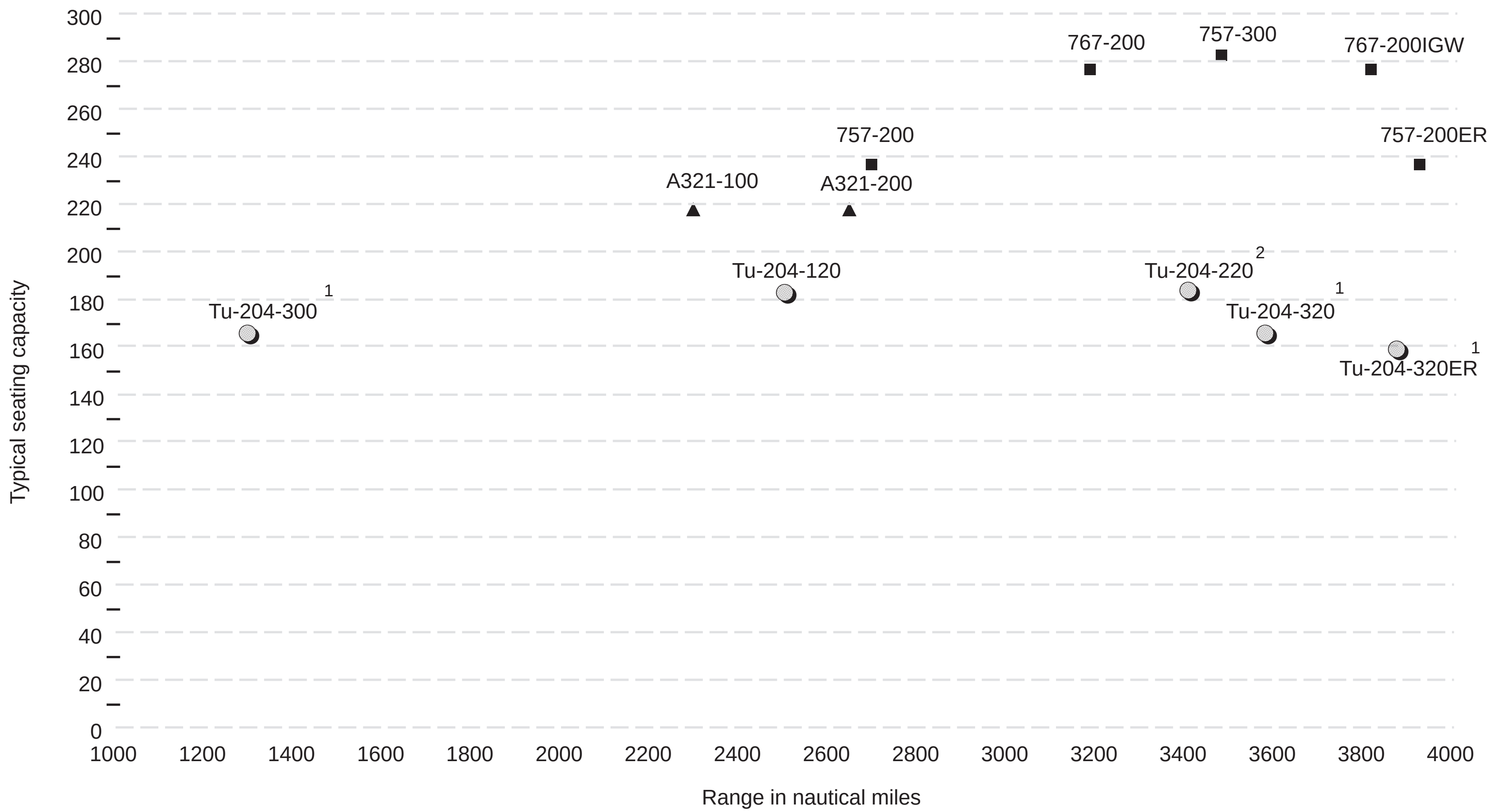
Figure F-5
Ilyushin Il-96T and similar Western aircraft



Note.—3 aircraft represented with an average payload of 98,596 kg.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft*, *1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

Figure F-6
Tupolev Tu-204 and similar Western aircraft



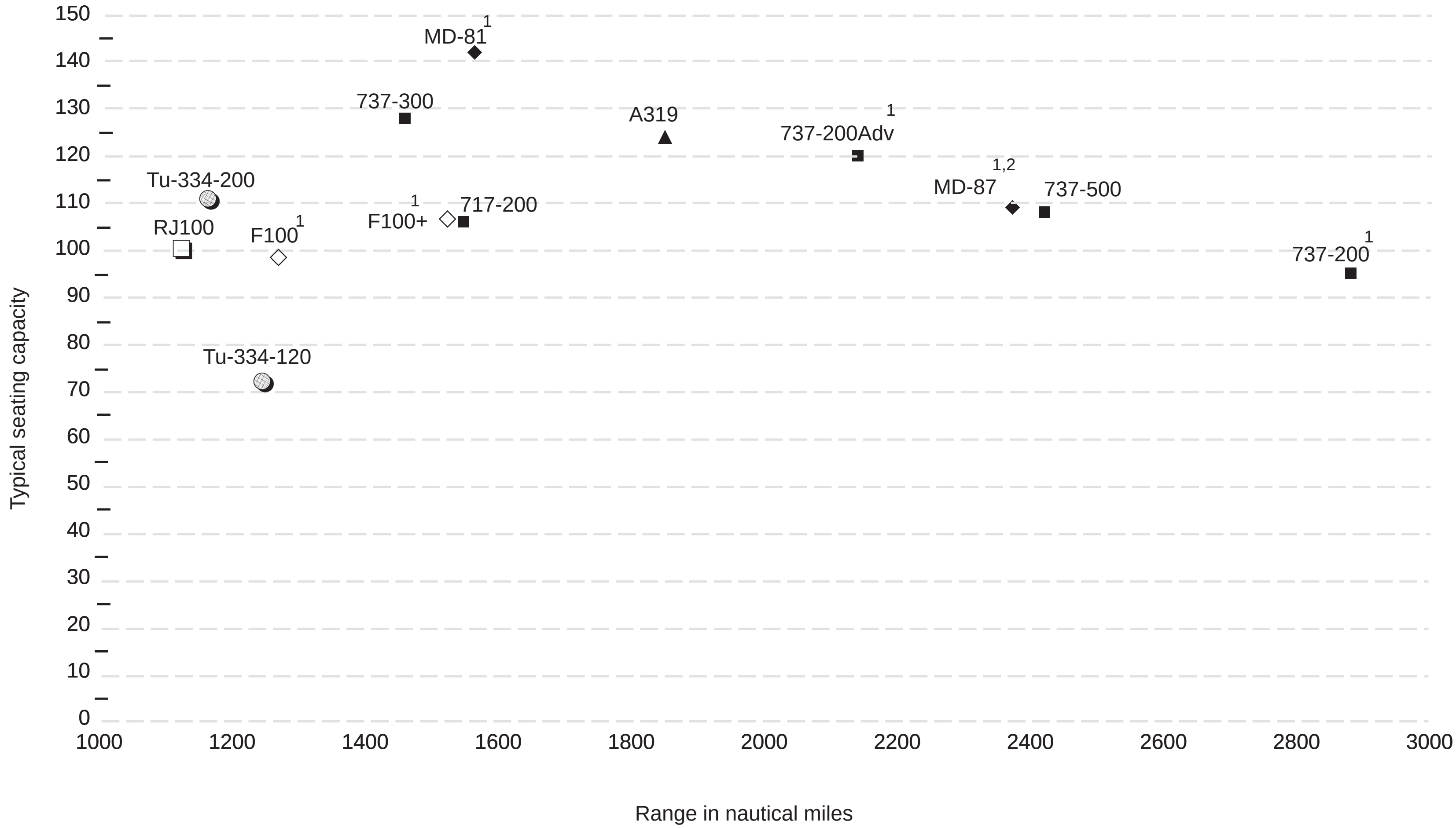
[1] High density seating.

[2] Range denotes that of the Tu-204-200 which is equipped with Russian engines. While no data are available for the Tu-204-220 with Western engines, its range will likely exceed 3,415 nautical miles.

Note.—12 aircraft represented with an average seating capacity of 218.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft*, *1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

Figure F-7
Tupolev Tu-334 and similar Western aircraft



[1] No longer in production.

[2] Range with 130 passengers.

Note.—13 aircraft represented with an average seating capacity of 109.

Source: USITC estimates based on data from Airbus Industries, G.I.E; The Boeing Company; Paul Jackson, ed., *Jane's All the World's Aircraft, 1997-98* (Surrey, UK: Jane's Information Group, 1997); and GRA Aviation Specialists, Inc.

APPENDIX G

OFFSETS

OFFSETS

The term "offsets" encompasses a broad range of compensation practices that are required by certain governments as a condition of purchasing defense or commercial products from foreign sources. Offsets are required by governments for a variety of reasons, such as to increase domestic employment, to obtain desired technology, to ease the burden of large foreign purchases on a country's economy, or to promote a specific industrial sector. Offsets may take various forms, including coproduction, licensed production, subcontractor production, overseas investment, and/or technology transfers. Offsets may be characterized as either direct or indirect or a combination of both, depending on whether the goods or services agreed upon are an integral part of the purchased product.[816]

In general, several agreements limit offset trade in the global large civil aircraft (LCA) industry. First, two agreements govern trade in civil aircraft and components: the 1979 GATT Agreement on Trade in Civil Aircraft, and the 1992 Agreement Between the United States and the European Economic Community Concerning the Application of the GATT Agreement on Trade in Civil Aircraft on Trade in Large Civil Aircraft.[817] These two agreements, to different degrees, contain provisions limiting government-mandated procurement between signatories.[818] In addition, the 1996 WTO Agreement on Government Procurement (GPA)[819] limits offsets in government procurement in all but "national security" and certain other areas. However, none of these agreements contains specific prohibitions on offsets in non-defense and non-government procurement trade.[820]

Effects on Global LCA Industry

Historically, offsets have been a defense-related concern. But as the ability to design and manufacture LCA increasingly is viewed by many nations as emblematic of first-class citizenship in the high-technology industrial economy,[821] an increasing number of nations with fledgling

[816] In a direct offset, the producer of the exported product may use a component during manufacturing that is made in the purchasing country. In an indirect offset, the producer obtains products from the purchaser that are peripheral to the manufacture of its final product.

[817] The Agreement on Trade in Large Civil Aircraft includes the United States, the European Union, and, separately, the governments of France, Germany, Spain, and the United Kingdom.

[818] The GATT Agreement contains stated prohibitions on government-mandated procurement from particular suppliers, mandatory subcontracting, and specified inducements which would result in discrimination against suppliers from any signatory. The Agreement on Trade in Large Civil Aircraft adopts the GATT Agreement prohibitions with interpretations intended to prohibit government-mandated decisions which could result in discriminatory treatment. Manufacturers Alliance, "Offsets in Foreign Sales of Defense and Nondefense Equipment, A Manufacturers Alliance Review," Feb. 1997, p. 3.

[819] GPA signatories among LCA- and parts-producing countries include the United States, members of the EU, as well as Korea, Japan, and Singapore.

[820] Manufacturers Alliance, "Offsets in Foreign Sales of Defense and Nondefense Equipment," p. 3.

[821] Randy Barber & Robert E. Scott, "Jobs On the Wing: Trading Away the Future Of the U.S. Aerospace Industry," *Competition Pressures the U.S. Aerospace Industry to Outsource Jobs and*

(continued...)

aerospace industries are eager to enter into offset agreements with global LCA manufacturers as a means of enhancing their aerospace capabilities. Moreover, the principal global LCA manufacturers view offsets as a necessary method for obtaining access to foreign markets. This growing use of offset arrangements required by purchasers of civil aircraft, however, has heightened concern among certain sectors of the U.S. aerospace industry regarding employment and the industry's international competitiveness.[822] Aerospace industry labor representatives maintain that the increased use of offsets and offset-like arrangements[823] pose serious risks for the U.S. supplier base and for the competitiveness of the U.S. aerospace industry, in that they result in the transfer of U.S. jobs and technology to overseas competitors.[824] While most of these aspiring producer countries are not likely to pose an immediate threat to the competitiveness of U.S. LCA manufacturers (primarily because they lack high-technology design capability and because they lack the integrated process management skills necessary to produce their own LCA), these producers do manufacture numerous aircraft components and structures and compete directly with U.S. suppliers of lower-technology components and structures, and conceivably pose a significant challenge to this segment of the U.S. aerospace industry.

[821] (...continued)
Production, Washington, DC: Economic Policy Institute, 1995, p. 23.

[822] Manufacturers Alliance, "Offsets in Foreign Sales of Defense and Nondefense Equipment," p. 3.

[823] The term "offset-like arrangements" is used here to refer to commercially-generated offsets not mandated by the government of the purchaser country.

[824] International Association of Machinists and Aerospace Workers, posthearing submission, USITC inv. No. 332-384, pp. 4-5.

APPENDIX H

AN ANALYSIS OF MARKET SEGMENTATION WITHIN THE NARROW-BODY AIRCRAFT MARKET

AN ANALYSIS OF MARKET SEGMENTATION WITHIN THE NARROW-BODY AIRCRAFT MARKET

The analysis of market segmentation within the narrow-body turbofan-powered aircraft market focuses on the fact that most goods and services offered for sale represent a unique combination of underlying features, properties, or characteristics that address the ultimate customer requirements. In the case of aircraft, all airliners fulfill the basic requirement of transporting passengers and/or cargo by air. However, in addition to this general requirement, numerous other properties and characteristics, such as passenger and freight capacity, range, reliability, and efficiency of operations, are used to differentiate airliners. This analysis identifies and quantifies the most important observable characteristics of narrow-body airliners and uses those characteristics to evaluate segments within the market.

As discussed in Chapter 6, the analysis described in this appendix addresses whether the 100-seat aircraft is best described as: 1) indistinguishable from the general LCA market; 2) part of an emerging 70- to 120-seat market segment; or 3) part of a regional jet aircraft market. Results from this analysis do not produce definitive answers to the market segmentation question; instead, the results must be interpreted based on how similar airliner types are to one another.

The investigation proceeds on two levels. First, the most important airliner factors are identified using information on both prices and measurable characteristics for a subset of 32 narrow-body aircraft.[825] Once these key characteristics are identified, two analyses are conducted to determine how similar each aircraft model is to the other models included in the investigation. The first analysis identifies how similar each pair of aircraft are to one another when compared against all other models. The second analysis attempts to directly quantify the economic distance between each pair of aircraft models.[826]

Methodology and Analyses

Quantifying Important Aircraft Characteristics

An evaluation of responses to questionnaires received from airlines for this study reveals that a large number of factors are considered when airlines make fleet acquisition decisions. An airline simultaneously evaluates its specific route structure, current fleet, route-specific passenger traffic projections, financing options, as well as the price and performance characteristics of aircraft offered for sale. Based on the significant elements associated with passenger preferences, airline requirements, and aircraft characteristics, fleet acquisition is generally reduced to a comparison of the financial return (present-value lifetime revenue less present-value lifetime costs) of each

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[825] Price and characteristics information were collected from *The Guide* (Herndon, VA: GRA Aviation Specialists, Inc., vol. 3, November, 1997). All narrow-body airliners listed in that publication are used in the first part of the analysis that identifies the set of important characteristics.

[826] Economic distance refers to the distance, in characteristic space, weighted by the relative magnitude of each significant characteristic explaining aircraft prices or valuations.

alternative aircraft. Therefore, numerous characteristics of passengers preferences, airlines, and aircraft influence this decision.

Many tangible and intangible characteristics are associated with an airliner, and the value of an aircraft should be related to the unique combination of important characteristics it contains. However, only measurable characteristics can be used in this type of analysis.[827] Therefore, the first step in the analysis was to obtain consistent measures of valuations (prices) and characteristics that either directly or indirectly influence the function/appeal of an aircraft in the market. Data on the typical seating capacity, maximum seating capacity, and maximum takeoff weight were collected to represent the revenue generating capacity of airliners. Similarly, the revenue capability and the appeal/necessity of nonstop flight was expected to be captured by measures of the typical and maximum aircraft ranges. The number of turbofan engine models certified for an aircraft as well as differences (both in absolute and percentage terms) between the typical and maximum seating capacity and range were also identified, as those measures might highlight important flexibility or adaptability features of an aircraft model.

The effect of an aircraft having more engine competition between producers was proxied with data identifying the number of manufacturers or manufacturing groups with engines certified for each aircraft. Noise certification status (Stage 2 or Stage 3) was collected because Stage 2 aircraft must be phased out, fit with new engines or noise reduction kits, or sold to airlines servicing limited markets not enforcing Stage 3 noise standards.[828] Chronological age of the aircraft was recorded because the value of an airliner declines as it ages and pricing data used in the analysis included both new and used airliners.[829] Age of the technology (i.e., an indicator of efficiency) embodied in the airframe was proxied by the year each aircraft model was first delivered.[830] Airframe manufacturers were identified as a means of attempting to capture the commonality benefits of a particular group of aircraft models. Finally, two physical characteristics, airliner length and wing span, were recorded to determine if these characteristics might identify some non-obvious effect on aircraft values, after controlling for other factors.

To maximize consistency between characteristics measures and the valuations used in the analysis, valuations and characteristics data were obtained from *The Guide*. Data missing from *The Guide* were obtained from various issues of *Jane's All the World's Aircraft* and manufacturer internet sites. Table H-1 lists all 32 narrow-body aircraft models with data available for the first stage of this analysis.

[827] With respect to other factors such as direct operating costs, appropriate data were not available for this analysis.

[828] A binary variable recorded whether an aircraft satisfied Stage 3 (one) or Stage 2 (zero) noise standards. The phase out of Stage 2 aircraft, to be completed by December 31, 1999, was mandated by the Airport Noise and capacity Act of 1990 and subsequent FAA rulings.

[829] For each aircraft, only prices for the latest model year were used. Age was recorded as the difference in years between 1999 and the model year for the aircraft valuation that was used.

[830] Age was recorded as the difference in years between 1999 and the year the aircraft model was first introduced.

Table H-1:
Aircraft models represented in the analysis identifying significant product characteristics

AVRO RJ70	Boeing 737-500	Fokker 70
AVRO RJ85	Boeing 737-600	Fokker100
AVRO RJ100	Boeing 737-700	McDonnell Douglas DC-9-30
Airbus A319 IGW	Boeing 737-800	McDonnell Douglas DC-9-51
Airbus A320-200	Boeing 757-200	McDonnell Douglas MD-81
Airbus A321-100	Boeing 757-200ETOPS	McDonnell Douglas MD-82
Airbus A321-200	British Aero. BAe146-100	McDonnell Douglas MD-83
Boeing 727-200Adv.	British Aero. BAe146-200	McDonnell Douglas MD-87
Boeing 737-200Adv.	British Aero. BAe146-300	McDonnell Douglas MD-88
Boeing 737-300	Canadair CRJ-100ER	McDonnell Douglas MD-90-30
Boeing 737-400	Embraer EMB-145ER	

Source: *The Guide*, GRA Aviation Specialists, Inc., Reston VA.

To identify the set of characteristics valued most within the aircraft market, an analysis was conducted in which prices were regressed against the set of observable aircraft characteristics.[831] The price of an airliner is expected to increase with a greater range and capacity, as well as compliance with more stringent (Stage 3) noise standards. The age of an aircraft also impacts its market value; newer aircraft yield higher prices.

A binary variable was constructed to indicate whether the aircraft was produced by either Boeing/Airbus or whether it was produced by a third manufacturer. Given the size of the installed fleet of these two manufacturers, valuations were expected to be positively related to this variable if non-trivial benefits are associated with fleet commonality and the two major aircraft producers are able to obtain a measurable price premium due to this benefit. Since engines are generally purchased separately from the airframe, and engine prices are likely to be lower (than they would otherwise) when there are a larger number of engine suppliers, airliner valuations were expected to be positively associated with the number of engine suppliers. Finally, newer technology embodied in an airframe should indicate more efficient components and design. Therefore, older airframe technology should be associated with a lower-valued airliner, holding other factors constant.

The full set of characteristics listed above were examined. Factors were retained in the second step of the investigation only if their estimated coefficients were statistically significant.[832] Several characteristics were examined and omitted because of multicollinearity problems when they were included in the regressions. In particular, variables representing the physical size of an aircraft, such as the length, wing span, and maximum takeoff weight, were highly correlated with the range and capacity measures which are intuitively more meaningful. The characteristics included in the final regression were range, capacity, aircraft age, and noise rating of the aircraft.

[831] This analysis determines the set of factors and the weights placed on each factor to best explain price variation across the different aircraft models. Although sufficient data existed to conduct a panel analysis, for each particular aircraft model, price variations across time appeared to be based solely on a relatively linear depreciation schedule. Hence, this type of analysis would have been inappropriate.

[832] Alternative approaches can be used to identify whether variables should be included/omitted from the regression, such as maximizing the AIC statistic, but the importance of range, capacity, and aircraft age made it unlikely that the results would be appreciably altered.

Equation (1) identifies the final regression model (model 1) which was used to determine parameters necessary for the second part of the market segmentation analysis.[833]

(1) $P_i = \beta_0 + \beta_1 * \text{Range} + \beta_2 * \text{Capacity} + \beta_3 * \text{Noise Rating} + \beta_4 * \text{Age} + u_i$

Regression estimates of equation 1 are shown in table 2 (model 1).[834] Because a log-log specification was used to estimate the equations, coefficient estimates for the continuous variables have a straightforward interpretation as elasticities. Therefore, using the results from model 1 for a new aircraft, a one percent increase in the typical range and capacity of an airliner is associated with a roughly 0.24 and 0.61 percent increase in aircraft valuations, respectively. Holding other factors constant, an aircraft satisfying Stage 3 noise standards is roughly $1.8 million more valuable than one which only meets Stage 2 standards.[835] Finally, a one-percent increase in aircraft age is estimated to reduce the value of an airliner by 0.331 percent, on average.[836]

These coefficient estimates are all significant and are robust to the inclusion of other variables in the regression. This is illustrated in models 2, 3, and 4 which show the results of three additional specifications.[837] These three models illustrate the effects of including variables identifying Boeing/Airbus products, age of the airframe technology, and the number of engines rated for each model of aircraft, respectively. Although the coefficient estimates for each of these variables produced the expected sign (i.e., effect),[838] they were excluded from the second stage of the analysis since the coefficient estimates were not statistically significant, meaning they were not statistically different from zero.

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[833] The previous discussion implies that β_1, β_2, and β_3 are expected to be positive, and β_4 should be negative.

[834] Tests for heteroskedasticity showed it to be present in each regression, so the reported standard errors are corrected using White's procedure. Regressions were estimated using the TSP software package.

[835] Hush kits for a 727-200Adv. are reported to range from $2.02 million to $2.63 million in GRA Aviation Specialists, *The Guide*, p. 48.

[836] As estimated, absolute depreciation levels are estimated to be nonlinear (in years), with higher depreciation in early years and a lower level in later years.

[837] In addition to robust coefficient estimates, the regressions explain over 93 percent of the price variation across aircraft models, as the adjusted R^2 measures exceed .93.

[838] The signs of the coefficients imply that Boeing and Airbus may be able to extract slightly higher prices for their aircraft, older airframe technologies are associated with lower aircraft valuation, and aircraft appear to have a premium when a larger number of engine options are available. In each case, these factors are estimated holding constant all other product characteristics.

Table H-2:
Regression results quantifying the relationship between aircraft characteristics and estimated market valuations

Characteristic (variable)	Model 1	Model 2	Model 3	Model 4
	Estimated coefficient (Standard error)			
Typical range	0.244 [1] (0.124)	0.205 [1] (0.111)	0.204 [1] (0.118)	0.205 [1] (0.120)
Typical capacity	0.605 [2] (0.117)	0.590 [2] (0.122)	0.592 [2] (0.136)	0.588 [2] (0.143)
Noise rating (Stage 2/3)	0.598 [2] (0.204)	0.644 [2] (0.170)	0.642 [2] (0.167)	0.644 [2] (0.1709)
Age of the aircraft * typical capacity	-0.331 [2] (0.045)	-0.314 [2] (0.049)	-0.312 [2] (0.049)	-0.311 [2] (0.053)
Boeing/Airbus		0.063 (0.086)	0.061 (0.091)	0.058 (0.097)
Airframe age			-0.003 (0.029)	-0.006 (0.040)
Number of approved engines				0.009 (0.076)
Constant	-1.851 [2] (0.590)	-1.563 [2] (0.669)	-1.558 [2] (0.676)	-1.555 [2] (0.702)
Number of observations	32	32	32	32
Adjusted R^2	0.943	0.942	0.939	0.937
Sum squared residuals	0.5736	0.6081	0.6081	0.6081

[1] Statistical significance between the 90 and 99 percent level.
[2] Statistical significance at the 99 percent level.

Source: USITC staff calculations

Market Segmentation

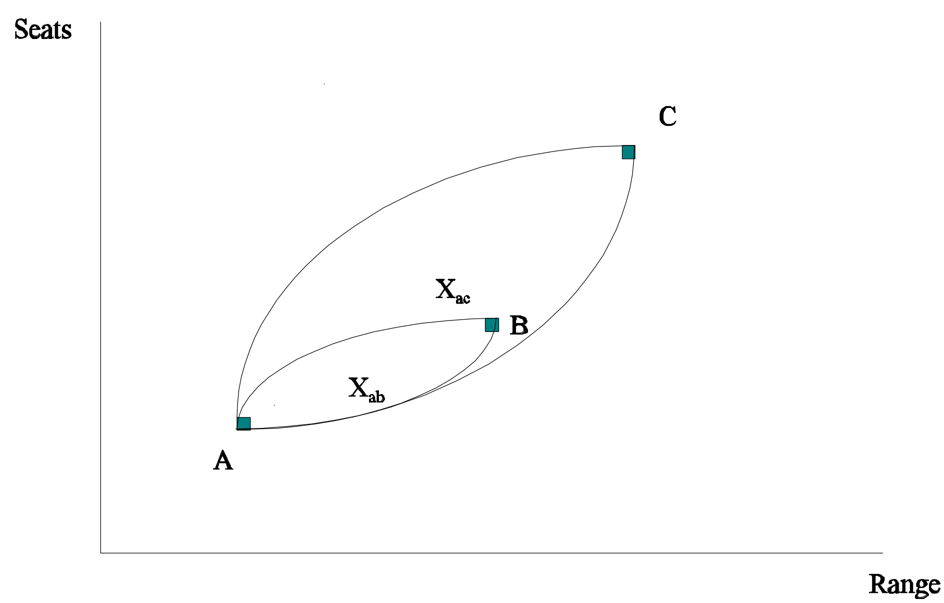
Primary Analysis

Because aircraft demand is derived directly from the preferences and requirements for airline travel, the analysis is designed to identify and distinguish the requirements of airlines from the specific products available for purchase. This analysis explicitly separates the two market participants, recognizing that only very infrequently are airline requirements exactly met by aircraft produced for the market. Instead, given comparable price levels, airlines purchase aircraft that are most similar to their required specifications. The primary analysis described in this section compares aircraft when the “true” or “optimal” set of airline requirements are near, but (generally) different from the characteristics embodied in available products.[839] A secondary analysis attempts to directly measure the economic distance between each pair of aircraft. Market segmentation is determined by evaluating the set of product "neighbors" that exist for each aircraft model.

Once product neighbors are determined, 100-seat models are compared to airliners generally associated with the LCA market and those associated with the established regional turbofan market (below 70 seats) to determine whether patterns of clustering exist within or across the different groups of airliners. The newly proposed 100-seat airliners are much more closely aligned with established (though no longer produced) 100-seat aircraft than they are to either LCA or small, regional turbofan models.

Figure H-1 illustrates the primary approach used to determine product neighbors. Three aircraft are depicted by the points A, B, and C which plot the aircraft based on two key product characteristics, typical seating capacity and typical range.

Figure H-1:
Example of airliner models and optimal configurations used to evaluate product neighbors



As described above, given the availability of these aircraft, airlines will obtain bids for several airliners that are close, though not identical to their optimal choice. Therefore, in this analysis, intermediate points are selected between each pair of aircraft to represent a potential optimum airline choice. For example, the point X_{ac} identifies one possible airliner configuration between

[839] A similar type of analysis is described for the automobile market in James Levinsohn, "Empirics of Taxes on Differentiated Products: The Case of Tariffs in the U.S. Automobile Industry," Robert E. Baldwin, ed. , *Trade Policy Issues and Empirical Analysis,* (Chicago, IL: University of Chicago Press, 1988), pp. 11-44. That study analyzed automobiles to determine product neighbors which were used in constructing price indices of autos that competed with each other. Although that analysis derived results based on final demand and consumer utility maximization, this analysis borrows heavily from that study.

aircraft A and C. The optimum (X_{ac}) is chosen using a metric described below such that points A and C lie on an ellipse representing points that are equidistant from the selected optimum.[840] The pair is then tested against all other airliners to determine if one (or more) alternative aircraft is closer to the optimum choice than the pair being tested. In this case, the airliner represented by point B is inside the ellipse, and thus is closer to the optimum X_{ac} than points A and C. Therefore, the pair (A and C) are not considered neighbors because the third aircraft (B) is closer to one or the other airliners being tested than they are to each other. If no other aircraft lies inside the ellipse, the aircraft pair are considered product neighbors. This is shown in the comparison of points A and B. The optimum X_{ab} is chosen to lie between A and B and when compared to point C, the pair are found to be closer than the alternative and thus are neighbors.

Products are evaluated based on a surplus or net profit function (equation 2) defined to proxy the profit available from an aircraft that embodies a set of characteristics, *z*, that are different from the set of characteristics, *z**, which an airline might identify as optimal for its operation.[841] Profit (Π) is calculated as net operating revenue of an aircraft (*R*) less the total costs of purchase (*P*):

(2) $$\Pi\left(z,z^{*}\right) = R\left(z,z^{*}\right) - P(z) .$$

The net revenue function is derived below. As discussed in the previous section, the price of an aircraft [*P*(*z*)] depends on the characteristics represented in the model.

The net operating revenue function is based on underlying characteristics of a product, as well as a set of preference/institutional factors, *r*, and is represented as a constant elasticity of substitution function:

(3) $$R(z,r) = \sum_{i}^{n} r_i \, (z_i^{d} - 1) / d ,$$

where the parameter δ reflects the elasticity of substitution between characteristics

$$- \infty < \left(\frac{1}{d - 1}\right) < 1.$$ [842] [843]

To simplify the analysis, both separability in the decision process and exogenous airline route demand is assumed. The decision process entails maximizing operating revenue of this airliner decision and additively separable numeraire operations N:

(4) $$\underset{z,N}{Max}\, R(z,r) + N$$

subject to $P(z) + N \leq D$, where D represents the exogenous demand that exists for an airline route structure. Substituting equation (3) and the solution to (4) into equation (2) yields the expression:

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[840] The ellipse is centered on the optimum point.

[841] Variables represent vectors unless explicitly indexed with a subscript, a notation used to identify individual elements of a vector.

[842] In writing equation (2), all characteristics are redefined using a Box-Cox transformation, and the characteristics themselves are in logarithmic form. Binary variables are defined so the logarithmic value is either zero or one.

[843] The analysis is only slightly sensitive to the elasticity of substitution between characteristics. Values of δ were chosen between -1.5 and -3.0 to analyze the sensitivity; a value of -2.25 was used to determine the results reported in table I-3.

$$\Pi\left(z, z^{*}\right) = \exp\left(C + \beta \ \ln z^{*}\right)\sum_{i}^{n}\left(\frac{\beta_i}{\delta}\right)(z_i^{*})^{1-\delta}\left(z_i^{\delta} - 1\right) - \exp\left(C + \beta \ \ln z\right). \tag{5}$$

This relationship implies that profits are maximized by products that have a set of characteristics (z) equal to the optimum bundle ($z*$). Therefore, airlines evaluate aircraft that are most closely associated with their optimal characteristics bundle in specific fleet competitions. If more than one product is similar to the optimum bundle, they should compete for the same markets and are therefore considered neighbors in this analysis. Therefore, the analysis identifies airliners as neighbors if they border on empty spaces within the product space representing possible airline demand points.

For each pair of aircraft, an optimal characteristics bundle was selected to equate the value of $\Pi(z, z*)$ for the aircraft pair. Each of 62 aircraft were individually analyzed, with 61 optimal characteristic choices examined for each specific aircraft.[844] The roughly 1,900 pairs were then tested against the remaining 60 models included in the analysis.[845]

In the previous section, determinants of aircraft price or valuations were analyzed and shown to be explained by four key airliner characteristics. However, only typical range and seating capacity remain as viable factors that airlines have available in deciding upon a new aircraft model. Depreciation was included in the earlier regression analysis to control for the different aircraft age; however, it was excluded from this analysis because aircraft neighbors would have a tendency to cluster by age, though airlines typically do not consider chronological aircraft age as a desired factor. Similarly, measures of noise certification were used in the regression analysis to control for the effects of an aircraft not meeting current environmental standards. The noise certification characteristic is not included in the analysis of product neighbors because Stage 3 noise standards are generally a requirement of new purchase decisions and airlines can not choose the level of noise certification under which they would prefer to operate an aircraft.

Supplemental Analysis

To gauge the robustness of the primary analysis results, a secondary set of comparisons was calculated. In this case, the economic distance between each pair of airliners was measured and the five most closely related aircraft are reported. This approach is relatively simple as it measures the gap between each pair of aircraft using the surplus function in the previous analysis. Rather than selecting an optimum characteristic bundle for each pair of aircraft, this methodology directly compares models. Equation (5) is adapted for this analysis by assuming that the optimum characteristics bundle is represented by a particular airliner. The distance between that aircraft and all other airliners is calculated by determining the surplus calculated for all other aircraft when airlines prefer to have the one being used to represent the optimum. Formally, for a specific

[844] The 32 aircraft used in the first (regression) step of the analysis are a subset of the 62 airliners considered in this second step.

[845] Analyzing 1,900 possible pairs of aircraft required an equal number of optimal airline characteristic choices to be calculated. Product neighbors are determined only from these potential combinations, though an infinite number of possibilities exist in the characteristics space. One shortcoming of choosing "optimal" characteristic combinations between pairs of aircraft is that it ignores all possible characteristic combinations that are outside the minimum and maximum values represented by the 64 aircraft included in the analysis. The GAMS software package was used to calculate the optimal characteristic bundle for each product pair as well as the roughly 270,000 product comparisons required for the analysis.

aircraft (denoted by z^*), the surplus function $\Pi\left(\tilde{z}, z^*\right)$ illustrated in equation (6) is calculated to compare each of the remaining aircraft ($\tilde{z}$) to the one considered optimal:

$$(6) \qquad \Pi\left(\tilde{z}, z^*\right) = \exp\left(C + \beta \ \ln z^*\right)\sum_{i}^{n}\left(\frac{\beta_i}{\delta}\right)(z_i^*)^{1-\delta}\left(\tilde{z}_i^{\delta} - 1\right) - \exp\left(C + \beta \ \ln \tilde{z}\right).$$

Rather than comparing an aircraft pair to all other available aircraft, this analysis simply calculates a distance, in product space, between alternative airliners. Therefore, results from this analysis rank the distance between all aircraft pairs, without considering the specifications or number of aircraft that may be more similar to an optimum airline specification.

All aircraft used in the analyses are shown in table H-3, along with measures of the two key variables, typical range and seating capacity. These models include both currently available airliners as well as those that are being proposed for production. Table H-3 also shows the results from the two complementary analyses. The numbering of an aircraft in the list is used to identify neighbors in the results columns. For each airliner listed, the fourth column in table H-3 shows all aircraft that were found to be product neighbors using the primary analysis that employed equation (5).[846] The last column reports the closest five airliners found in the secondary analysis using equation (6) to calculate the distance between models.[847]

The two product neighbor analyses produce similar results, but they are not expected to yield identical results. For example, the first aircraft listed, the AVRO RJ70, was found to have five product neighbors: the Canadair CRJ-200LR, the Fairchild-Dornier F528 and F728 models, and the Fokker F28 and F70+ models. When a midpoint was selected between the AVRO RJ70 and each of these models, no other aircraft in the analysis was determined to be within the ellipse that equated the pair of aircraft. The secondary analysis indicates that the Canadair CRJ-700 and Fokker 70 were the second and fifth closest aircraft models in product space, but they were not identified as product neighbors in the primary analysis because other aircraft exist that were very similar to those models and were determined to be more substitutable for the optimal characteristic configuration.

The number of aircraft identified in each analysis is also likely to differ. Note that the second aircraft listed in table I-3, the AVRO RJ85, is determined to have only two product neighbors, though the secondary analysis always lists the five closest aircraft in product space. The Boeing 737-300 was found to have six product neighbors in the primary analysis, the most of any aircraft model.

[846] These aircraft are listed in numerical order within the table. The primary analysis identifies whether an aircraft is a product neighbor or not, but does not rank the closeness of a product neighbor.

[847] Aircraft are listed in the order, from the closest aircraft models in product space to the more distant.

Table H-3:
Data and results for aircraft models included in the market segmentation comparison

Description	Range[1]	Seats[1]	Primary analysis[2]	Secondary analysis[2]
	(n. miles)	*(number)*	*model number of product neighbors*	
1. AVRO RJ70	1415	70	38, 43, 44, 45, 47	44, 39, 45, 47, 46
2. AVRO RJ85	1230	85	33, 50	33, 32, 47, 46, 50
3. AVRO RJ100	1195	100	34, 50	34, 50, 62, 51, 11
4. Airbus A319M5	1850[3]	106	5, 13, 52, 58	52, 11, 51, 58, 20
5. Airbus A319	1850	124	4, 15, 16, 55	15, 16, 17, 55, 58
6. Airbus A319IGW	3550	124	23, 24, 25	24, 25, 23, 60, 19
7. Airbus A320-200	2650	150	12, 19, 61	19, 61, 12, 8, 60
8. Airbus A320-200IGW	2950	150	25, 26, 61	61, 7, 19, 26, 60
9. Airbus A321-100	2300	185	10, 26	10, 26, 28, 29, 27
10. Airbus A321-200	2650	185	9, 26, 28, 29	9, 28, 29, 26, 27
11. Boeing 717	1547	106	51, 52, 62	51, 52, 62, 4, 34
12. Boeing 727-200Adv.	2475	148	7, 19, 57, 60	60, 19, 57, 7, 61
13. Boeing 737-100	2160	85	4, 14, 49, 50, 51	49, 48, 51, 4, 11
14. Boeing 737-200	2880	95	4, 13, 20, 21	20, 21, 58, 59, 22
15. Boeing 737-200Adv.	2140	120	5, 17, 58, 59	5, 17, 58, 20, 21
16. Boeing 737-300	1459	128	5, 52, 53, 54, 55, 62	54, 5, 55, 15, 52
17. Boeing 737-300IGW	2270	128	15, 24, 56, 57, 59	15, 56, 5, 18, 57
18. Boeing 737-400	2090	146	56, 57	56, 57, 12, 60, 19
19. Boeing 737-400IGW	2700	146	7, 12, 60	7, 60, 12, 61, 57
20. Boeing 737-500	2420	108	14, 21, 58	58, 21, 59, 15, 14
21. Boeing 737-500IGW	2740	108	14, 20, 59	59, 20, 58, 22, 15
22. Boeing B737-600	3230	108	23, 59	22, 59, 21, 6, 24
23. Boeing 737-600IGW	3630	108	6, 22	23, 59, 21, 20, 58
24. Boeing 737-700	3200	128	6, 17, 60	6, 25, 60, 57, 19
25. Boeing 737-700IGW	3800	128	6, 8	6, 24, 8, 19, 60
26. Boeing 737-800	2930	162	8, 9, 10, 27, 61	27, 8, 61, 7, 28
27. Boeing 737-800IGW	3370	162	26, 28	26, 28, 8, 10, 61
28. Boeing 737-900	3140	177	10, 27, 30	10, 27, 26, 29, 9
29. Boeing 757-200	2700	201	10, 30, 31	10, 28, 9, 30, 27
30. Boeing 757-200ETOPS	3929	186	28, 29, 31	28, 29, 27, 10, 26
31. Boeing 757-300	3485	240	29, 30	30, 29, 28, 10, 9
32. British Aero. BAe146-100	1140	82	33, 46	33, 46, 2, 47, 45

Table H-3 continued: Data and results for aircraft models included in the market segmentation comparison--*Continued*

Description	Range[1]	Seats[1]	Primary analysis[2]	Secondary analysis[2]
	(n. miles)	*(number)*	*model number of product neighbors*	
33. British Aero. BAe146-200	1240	82	2, 32, 47	2, 32, 47, 46, 45
34. British Aero. BAe146-300	1220	103	3, 62	3, 50, 62, 51, 11
35. Canadair CRJ-100ER	1620	50	37, 42, 43	37, 38, 43, 42, 36
36. Canadair CRJ-200	965	50	41, 42	41, 42, 43, 35, 37
37. Canadair CRJ-200ER	1645	50	35, 38	35, 38, 43, 42, 36
38. Canadair CRJ-200LR	1900	50	1, 37	37, 35, 43, 42, 1
39. Canadair CRJ-700	1702	70	40, 44	44, 40, 1, 47, 48
40. Canadair CRJ-700ER	2032	70	39, 48	39, 44, 48, 49, 47
41. Embraer EMB-145	800	50	36	36, 42, 43, 35, 37
42. Embraer EMB-145ER	1200	50	35, 36, 43	43, 36, 35, 37, 41
43. Fairchild Dornier F528	1200	55	1, 35, 42, 45	42, 35, 37, 36, 38
44. Fairchild Dornier F728	1600	70	1, 38, 39, 47	39, 1, 40, 47, 45
45. Fokker F28	1125	75	1, 46	46, 32, 1, 33, 47
46. Fokker F70	1070	79	32, 45	45, 32, 33, 2, 47
47. Fokker F70+	1415	79	1, 33, 44, 48	33, 2, 32, 44, 39
48. Fokker F70++	1855	79	40, 47, 49, 50	49, 40, 13, 47, 39
49. Fokker F70+++	2015	79	13, 48	48, 13, 40, 47, 39
50. Fokker F100	1290	97	2, 3, 48	3, 34, 62, 51, 2
51. Fokker F100+	1550	105	11, 13	11, 52, 62, 4, 34
52. Fokker F100++	1680	107	4, 11, 16	4, 11, 51, 62, 16
53. McDonnell Douglas DC-9-30	1100	119	16, 54, 62	62, 34, 11, 51, 3
54. McDonnell Douglas DC-9-51	1250	139	16, 53, 55	16, 55, 5, 53, 15
55. McDonnell Douglas MD-81	1564	142	5, 16, 54, 56	54, 16, 5, 56, 18
56. McDonnell Douglas MD-82	2050	142	17, 18, 55	18, 57, 17, 12, 60
57. McDonnell Douglas MD-83	2502	142	12, 17, 18, 60	60, 12, 19, 7, 18
58. McDonnell Douglas MD-87	2372	109	4, 15, 20	20, 21, 59, 15, 14
59. McDonnell Douglas MD87ER	2833	109	15, 21, 22	21, 22, 20, 58, 23
60. McDonnell Douglas MD-88	2618	143	12, 19, 24, 57	57, 19, 12, 7, 61
61. McDonnell Douglas MD-90-30	2770	152	7, 8, 26	8, 7, 19, 12, 60
62. Tupolev Tu-334	1300	110	11, 16, 34, 53	11, 51, 53, 34, 52

[1] Sources: *Jane's All the World's Aircraft*, (Surrey, UK: Jane's Information Group, Limited), various issues; Gregory Polek, "Fairchild Dornier Launches New Jets," *Aviation International News*, June 1, 1998, pp. 1, 42.

[2] USITC staff calculations

[3] Technical specifications have not been released by Airbus Industrie, G.I.E.; range is estimated based on the A319.

Conclusions

Based on a review of results in table H-3, the narrow-body turbofan aircraft market appears to be segmented into at least three parts. As discussed above, the degree of market segmentation is judged by the degree to which aircraft models cluster together. The degree of clustering is illustrated in table H-4 which summarizes the results from table H-3. Aircraft models are grouped into three categories; 70 seats and fewer, between 71 and 120 seats, and more than 120 seats. For aircraft that fall in each of the groups, table H-4 identifies the number of product neighbors that fall within the three groups.

Table H-4:
Summary of table H-3 product-neighbor results

	Number of product neighbors with seating capacity		
Aircraft with seating capacity	70 seats and fewer	71-120 seats	more than 120 seats
70 seats and fewer	25	5	0
71-120 seats	4	64	8
more than 120 seats	0	9	74

Source: USITC staff calculations

The summary results in table I-4 show that there are 76 product neighbors for aircraft with seating capacities of 71-120 seats. Sixty-four of those product neighbors are other aircraft with 71-120 seats. Of the remaining product neighbors, four were aircraft with 70 or fewer seats and eight aircraft had accommodations for more than 120 seats.

As discussed in the introduction of this Appendix, market segmentation is not identified with precision in this analysis. Instead, the results in table I-4 indicate a strong degree of market segmentation between the small (70 seats and fewer) models and the aircraft in the 71-120 seat category. Differences between aircraft in the 71-120 seat, and more than 120-seat categories are less definitive, but the higher degree of crossover between groups is largely due to a number of aircraft models in the 71-120 category that are smaller versions of aircraft optimized for a higher seating capability. The relatively long range of these aircraft make them more closely associated with aircraft in the more than 120-seat group.

Stronger segmentation appears at the lower end of the 100-seat market than at the upper end. The break between the small, 70-seats and fewer aircraft, and those in the 71-120 category is reinforced by the scope clauses in airline pilot contracts that limit the number and size of small turbofan aircraft operated within major airline service networks. Table H-5 summarizes scope-clause restrictions included in pilot labor contracts for most of the major U.S. carriers. Though airlines are attempting to loosen these restrictions to compete more directly against low-cost carriers, they remain a significant restriction in many fleet acquisition decisions. The 70-seat threshold appears to be a strong dividing line, and thus, reinforces the division between 100-seat airliners and the smaller regional turbofan aircraft.

Table H-5:
Descriptions of "scope clause" restrictions in a select number of major U.S. airlines

Airline	Limits on aircraft [1]	Limits on the number of aircraft [1]
American	Maximum RJ capacity - 70 seats Minimum RJ capacity - 45 seats Maximum average fleet size - 50 seats 550 nm flight maximum	Entire system limited to 67 RJs. If mainline American fleet drops below 628 aircraft, reduction of one RJ for every two aircraft below 628.
Continental	Maximum RJ capacity - 59 seats	No limit on number of RJs
Delta	Maximum RJ capacity - 70 seats exemptions for up to 20 RJs between 70 and 89 seats	No limit on number of RJs
Northwest	Maximum RJ capacity - 70 seats Currently under negotiation	Currently under negotiation
United Airlines	Maximum RJ capacity - 50 seats	Entire system limited to 30 RJs through the year 2000. After 2000, 3 RJs can be added for each mainline narrow-body aircraft.
US Airways	Maximum RJ capacity - 69 seats No RJ may operate on a route served by "mainline jets" in the previous 12 months.	The scope clause has incremental increases: First year - maximum of 12 RJs Second year - maximum of 15 RJs Third year - maximum of 25 RJs

[1] RJ refers to a regional turbofan aircraft.

Source: *Profile: Regional Jets and Their Emerging Roles in the U.S. Aviation Market,* Office of the Assistant Secretary for Aviation and International Affairs. U.S. DOT, June 1998.

The break between the 100-seat airliners and traditional LCA is less pronounced in table H-4, and is also weaker because no clear institutional factors divide these two categories of aircraft. However given the differences in seating capabilities as well as the significant differences in flight range, there appears to be a noticeable divergence between 100-seat aircraft and those models optimized for the more than 120-seat market.

The currently-proposed new 100-seat programs generally link them with established 70- to 120-seat aircraft rather than those aircraft at the lower end of the LCA market.[848] In instances where the new 100-seat aircraft are found to be most similar to existing aircraft models, those regional and LCA models are generally no longer produced. Therefore, as discussed in Chapter 6, demand is projected to result from proposed new 100-seat aircraft that open up new short-distance high-frequency service routes, but replacement sales will likely be the significant source of sales in the initial period after launch.

[848] When the proposed AE316 and AE317 were included in the analysis, the proposed Airbus 100-seat aircraft was much more closely related to the 100-seat market than the A319M5 aircraft (with the specifications being used for the analysis).