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Aviation: An Overview

Introduction
The Aerospace Industry
The Air Transportation Industry

Chapter Checklist • You Should Be Able To:

- Define *aerospace industry* and describe its basic characteristics and economic magnitude
- Discuss some of the problems faced by the government market
- Describe the current economic outlook for the three segments included in the civil aviation market
- Identify and briefly describe the factors affecting commercial transport sales
- Define related aerospace products and services
- Define *air transportation industry* and distinguish between certificated air carriers and general aviation
- Describe the impact of the air transportation industry on the economy
- Describe how air transportation contributes to the efficient conducting of business and affects personal and pleasure travel patterns

INTRODUCTION

In a short span of 100 years, we have gone from making a few test flights to orbiting celestial bodies, from sliding along sand dunes to spanning oceans, from performing feats of isolated daring to depending on aviation in our everyday lives. Speeds have increased a thousandfold, as have altitude and range capability. No longer is the sky the limit. Ahead lie risks and rewards as vast as space itself. We have the promise of new airliners that fly with greater fuel efficiency, of huge air freighters that move the nation's goods, of an expanding general aviation fleet, and of the peaceful uses of space for exploration and research.

THE AEROSPACE INDUSTRY

The **aerospace industry** includes those firms engaged in research, development, and manufacture of all of the following: aerospace systems, including manned and unmanned aircraft; missiles, space-launch vehicles, and spacecraft; propulsion, guidance, and control units for all of the foregoing; and a variety of airborne and ground-based equipment essential to the testing, operation, and maintenance of flight vehicles. Virtually all of the major firms in the aerospace industry are members of the **Aerospace Industries Association (AIA)** or the **General Aviation Manufacturers Association (GAMA).** Founded in 1919 and based in Washington, D.C., the AIA is a trade association representing the nation's manufacturers of commercial, military, and business aircraft, helicopters, aircraft engines, missiles, spacecraft, and related components and equipment. GAMA, also based in Washington, D.C., is the trade association that represents the interests of manufacturers of light aircraft and component parts.

As the 21st century began, approximately two-thirds of the aerospace industry's output was bought by the federal government. During the past two decades, this figure has ranged as high as 74 percent. At the same time, the aerospace industry is the world's largest producer of civil aircraft and equipment. Roughly 6 out of every 10 transports operating with the world's civil airlines are of U.S. manufacture, and in addition, the industry turns out several thousand civil helicopters and general aviation planes yearly.

These facts underline the unique status of the aerospace industry. Its role as principal developer and producer of defense, space, and other government-required systems in large measure dictates the industry's size, structure, and product line. Because it operates under federal government procurement policies and practices, the industry is subject to controls markedly different from those of the commercial marketplace. But the aerospace industry is also a commercial entity, and it must compete in the civil market for economic and human resources with other industries less fettered by government constraints. Its dual nature as government and commercial supplier makes the aerospace industry particularly important to the national interest. Its technological capabilities influence national security, foreign policy, the space program, and other national goals. Also, the efficacy of the national air transportation system depends to considerable degree on the quality and performance of equipment produced for the airlines and the airways operators.

Naturally, such an industry is vital to the U.S. economy, especially in the following areas:

1. *Trade balance.* The excellence of U.S. aerospace products has created strong demand abroad, with the result that the industry consistently records a large international trade surplus.
2. *Employment.* Despite several years of decline in number of workers, the aerospace industry remains one of the nation's largest manufacturing employers.
3. *Research and development.* The industry conducts more **research and development (R & D)** than any other industry, and R & D is a major long-term determinant of national economic growth.
4. *Impact on other industries.* A great many new aerospace-related products and processes have spun off from the initial aerospace requirement and have provided value to other industries, both in sales and in productive efficiency. In addition, the aerospace industry is a large-scale user of other industries' goods and services: it has been estimated that for every 100 aerospace jobs created, another 73 are created in other industries.

Each of these factors represents a significant contribution to the U.S. economy; collectively, they elevate aerospace to a key position among the nation's major industries.

Characteristics of the Industry

The history of the aerospace industry has been a saga of continuing adjustment to changing national policy and economic conditions. Since 1960, fluctuating government demands and a variety of international events have teamed up to produce a roller-coaster-like sales curve: up to a peak, down to a valley. Over the years, the industry's operations have become increasingly complex, with each increment of complexity heightening the industry's problems in adapting to change. Today, the industry's unique characteristics make the adaptive process extraordinarily difficult. An understanding of the difficulties is best promoted by an explanation of how the industry has been transformed in the past quarter of a century.

Prior to 1950, the industry was relatively unsophisticated. Its product line was entirely aeronautical—aircraft, engines, propellers, avionic components, and accessories. Long-run production of many airplane types was the order of the day. The labor force, during the post-World War II retrenchment period, was less than one-fifth of the later peak. Three-fourths of the workers were moderately skilled production workers. R & D was an essential prelude to production, but the subsonic aircraft then being built were less demanding of technological advance, and R & D represented a considerably less significant portion of the total workload than it does today.

The transformation began in the early 1950s with the production of the jet-powered supersonic military airplane, which brought about across-the-board changes in the industry—new types of engines, totally different airframes, different on-board equipment, new tooling and facilities, and, most of all, a vastly greater degree of complexity in products and the methods employed in producing them. New-airplane performance dictated that far greater emphasis be placed on R & D. The combination of R & D and product complexity required a major shift in the composition of the work force to include ever-increasing numbers of scientists, engineers, and highly skilled technicians. All of

these changes resulted in increased emphasis on an ever more sophisticated managerial process.

While the industry was adjusting to these changes, it inherited a new responsibility: development and production of guided missiles, particularly long-range ballistic weapons. Then came another major change: the application of turbine power to commercial airliners, whose resemblance to military jets ended with their propulsion systems. The need to transport large numbers of people at high subsonic speeds and multimile altitudes involved a further modification of the industry's methods. Finally, in the late 1950s, the industry was assigned still another responsibility: fabrication of equipment to meet the nation's goals in space exploration.

Each of these changes compounded the need for change in the entire industry—more R & D, greater product complexity, more personnel per unit produced, higher skill levels in the work force, longer program development time, and greater need for new facilities with only single-program utility because of their specialized natures. Such changes contributed to higher costs of the endproducts, and the demand in the 1960s and 1970s for still more advanced aerospace systems further escalated both the rate of change and the costs. In defense output, cost—together with the greater capability of the individual system—influenced a trend away from volume production and toward tailored manufacture of fewer types of weapons and fewer numbers of each type.

A half-century of evolution has left the aerospace industry with a set of characteristics unique in U.S. manufacturing:

1. Performance demands for new systems require continual advancement of the technological frontier, which in turn involves unusual degrees of uncertainty and risk.

2. Because the government is the principal customer, the product line is subject to revisions in program levels occasioned by changing requirements and funding availability.

3. Equipment that challenges the state of the art is necessarily costly, the more so because requirements generally dictate short production runs, negating the economies of large-scale production.

4. Technologically demanding programs require personnel emphasis in the higher skill levels. Hence, labor input per unit of output is substantially larger than in other manufacturing industries.

5. The combination of technological uncertainty and long lead times, often 7–10 years and frequently longer, between program initiation and completion, makes advance estimation of costs particularly difficult.

6. Because there are few customers and relatively few programs, competition for the available business is intense.

7. All of these characteristics contribute to exceptional demand for industry capital, yet profits as a percentage of sales are consistently well below the average for all manufacturing industries.

Economic Profile of the Industry

The aerospace industry is composed of about 60 major firms operating some 1,000 facilities, backed by thousands of subcontractors, vendors, and suppliers. The principal product line—aircraft, missiles, space systems and related engines, and parts and equipment—is characterized by high performance and high reliability, and hence high technology and high unit value.

Activity, as measured by sales volume, focuses on aircraft, both civil and military, which account for almost 55 percent of the industry's workload. Missile systems represent about 6 percent of the total, and space fabrication for about 21 percent. In addition, 17 percent comes from related products and services, which embrace the industry's growing efforts to transfer to the nonaerospace sector some of the technology developed in aerospace endeavors.

Sales in 2005 amounted to $170 billion, broken down as follows: aircraft, $89.1 billion; missiles, $15.3 billion; space-related materials, $37.3 billion; and related products and services, $28.3 billion. **Related products and services** include all nonaircraft, non-space vehicle, and nonmissile products and services produced or performed by those companies or establishments whose principal business is the development or production of aircraft, aircraft engines, missile and spacecraft engines, missiles, or spacecraft.

The early 1990s were difficult for U.S. aerospace companies. Declining defense spending and a protracted airline recession caused U.S. aerospace sales to plummet, resulting in the industry's worst downturn in 40 years. By 1996, the industry began to turn around (see Table 1-1). The 8 percent rise between 1995 and 1996 was largely attributable to increased sales of civil aircraft, engines, and parts. Sales of missiles have steadily increased for the years 2000–2005. This category should increase in the years ahead as the war on terrorism continues around the globe.

Changes in aerospace product sales are driven by the dynamics of the industry's customer base. During the 1980s, the Cold War environment set the tone for increased U.S. defense spending, and aerospace companies responded accordingly. In 1987, industry sales to the Department of Defense (DOD) accounted for 56 percent of total aerospace business. Yet federal spending priorities have gradually changed. The end of the Cold War and pressures to balance the federal budget led to spending cuts in defense programs. Aerospace sales to the DOD fell substantially between 1987 and 1999 (Table 1-2). There was a slight rise in defense spending in 2000 and 2001, largely as a result of the nation's war on terrorism following the tragedy of September 11, 2001. Higher procurement spending occurred in 2002 and beyond as the global war on terrorism continued.

Although DOD purchases continued to slide during the better part of the 1990s, the demand for commercial transports increased significantly with the resurgent economy and the return to profitability by the airline industry. General aviation sales also increased following passage of the General Aviation Revitalization Act in 1994. Both the airline and general aviation sectors were significantly affected by the slowdown in the economy starting in 2000 and continuing through 2002.

The aerospace industry represents one of the nation's largest employers, with approximately 625,000 workers on the rolls at the end of 2005. Combined with multiplier effects on other industries, it is estimated that the aerospace industry accounts directly or indirectly for close to 2 million U.S. jobs.

A labor-intensive industry, aerospace employs as many salaried as production workers, the highest such ratio among comparable industries. The emphasis on high-tech R & D in

TABLE 1-1 Aerospace Industry Sales By Product Group, 1990–2006 (millions of dollars)

Year	Total Sales	Aircraft			Missiles[a]	Space[a]	Related Products & Services
		Total	*Civil*	*Military*[a]			
CURRENT DOLLARS							
1990	$134,375	$ 71,353	$31,262	$40,091	$14,180	$26,446	$22,396
1991	139,248	75,918	37,443	38,475	10,970	29,152	23,208
1992	138,591	73,905	39,897	34,008	11,757	29,831	23,099
1993	123,183	65,829	33,116	32,713	8,451	28,372	20,531
1994	110,558	57,648	25,596	32,052	7,563	26,921	18,426
1995	107,782	55,048	23,965	31,082	7,386	27,385	17,964
1996	116,812	60,296	26,869	33,427	8,008	29,040	19,469
1997	131,582	70,804	37,428	33,376	8,037	30,811	21,930
1998	147,991	83,951	49,676	34,275	7,730	31,646	24,665
1999	153,707	88,731	52,931	35,800	8,825	30,533	25,618
2000	144,741	81,612	47,580	34,032	9,298	29,708	24,123
2001	151,632	86,470	51,256	35,215	10,391	29,499	25,272
2002 r	152,349	79,486	41,340	38,147	12,847	34,624	25,392
2003 r	146,625	72,844	32,441	40,402	13,488	35,857	24,438
2004	155,717	79,128	32,519	46,609	14,704	35,933	25,953
2005 p	170,055	89,117	39,165	49,952	15,287	37,308	28,343
2006 e	183,996	100,365	49,519	50,846	14,438	38,528	30,666

Source: Aerospace Industries Association, "Aerospace Facts and Figures, 2005."
[a] Includes funding for research, development, test, and evaluation.
[b] Estimate
r Revised
p Preliminary
e Estimate

the aerospace industry demands a greater number of scientists, engineers, and technicians than are utilized by most industries. At its peak, the aerospace industry employed almost 30 percent of all U.S. scientists and engineers engaged in R & D. The figure has still averaged a relatively high 15 percent for the past 20 years or so.

Testifying to the excellence of U.S. aerospace products is the strong performance of the industry on the international market. The industry has a significant impact on the U.S. balance of trade. Back in 1967, aerospace exports reached the $2-billion-a-year level, and in succeeding years, they rose sharply, mainly because of deliveries abroad of advanced-technology commercial jetliners. In 1973, the industry set an all-time export record of more than $5 billion, and in 1974, that figure increased by almost $2 billion. In 1981, there was another substantial increase, to a new record of $17.6 billion, and in 1986, the figure rose to $19.7 billion, which represented 9.6 percent of total U.S. exports. In 2005, exports topped $65 billion. At the same time, aerospace imports have traditionally amounted to only a fraction of the value of goods exported. Thus, aerospace has consistently shown a substantial trade surplus.

TABLE 1.2 Aerospace Industry Sales by Customer, 1987–2006 (millions of dollars)

Year	Total Sales	Aerospace Products and Services				Related Products and Services
		Total	*Department of Defense*[a]	*NASA and Other Agencies*	*Other Customers*	
1987	$110,008	$ 91,673	$61,817	$ 6,813	$23,043	$18,335
1988	114,562	95,468	61,327	7,899	26,242	19,094
1989	120,534	100,445	61,199	9,601	29,645	20,089
1990	134,375	111,979	60,502	11,097	40,379	22,396
1991	139,248	116,040	55,922[b]	11,739	48,379	23,208
1992	138,591	115,493	52,202	12,408	50,882	23,099
1993	123,183	102,653	47,017	12,255	43,380	20,531
1994	110,558	92,132	43,795	11,932	36,405	18,426
1995	107,782	89,818	42,401	11,413	36,004	17,964
1996	116,812	97,344	42,535	12,391	42,418	19,469
1997	131,582	109,651	43,702	12,753	53,196	21,930
1998	147,991	123,326	42,937	13,343	67,047	24,665
1999	153,707	128,089	45,703	13,400	68,986	25,618
2000	144,741	120,617	47,505	13,382	59,730	24,123
2001	151,632	126,360	50,118	14,481	61,761	25,272
2002r	152,349	126,958	57,701	16,385	52,872	25,392
2003r	146,625	122,188	64,009	15,522	42,656	24,438
2004	155,717	129,764	70,085	16,000	43,679	25,953
2005p	170,055	141,173	74,261	17,389	50,063	28,343
2006e	183,996	153,330	74,933	17,788	60,609	30,666

Source: Aerospace Industries Association, "Aerospace Facts and Figures, 2005."
[a]Includes funding for research, development, test, and evaluation.
[b]Estimate.
r Revised
p Preliminary
e Estimate

Industry Suppliers

Aerospace products perform very sophisticated functions and are complex and costly to manufacture. Because of this, aerospace companies do not attempt to design and assemble finished products entirely in-house. Instead, companies specialize and, where appropriate, contract work out to other companies. A major aircraft manufacturer may use over 15,000 suppliers in its transport manufacturing activities.

It should be noted that aerospace suppliers are predominantly U.S. companies. In fact, data from 2005 indicate that imports of aircraft parts, engines, and engine parts amounted to $27.8 million or approximately only 19 percent of total U.S. aerospace sales. In the case of Boeing, less than 4 percent of its supplier base is located overseas, and the foreign content of its commercial jets averages 13 percent. In short, aerospace helps drive the domestic economy.

Naturally, the largest amount of economic activity involved in the assembly of aerospace products occurs among aerospace companies themselves. One aerospace firm may be responsible for the design, assembly, systems integration, and final testing of a product,

such as an aircraft. That company subcontracts work to other aerospace manufacturers, who supply aircraft wings, tails, and engines. These relationships vary from program to program, with companies exchanging roles as prime contractor and subcontractor. The most recent figures suggest that this interchange, or intra-industry trade, accounts for approximately 34 percent of aerospace purchasing activity.

In addition, much of the aerospace sector's impact on the U.S. economy arises from the industry's position as a major consumer of goods and services supplied by firms outside of aerospace. These services include legal assistance, advertising, accounting, and data-processing activities. Other service industries that are prominent aerospace suppliers include wholesale and retail trade, finance, and insurance.

The importance and value content of electronic components in aerospace endproducts have grown significantly in recent years. Items such as antennas, electronic connectors, and liquid crystal displays are included within this commodity category. Their growing share of the value of aerospace systems and vehicles is due principally to two factors. First, electronic component costs are being driven upward by Pentagon demands for state-of-the-art technology. This demand, coupled with the short production runs inherent in most military programs, has increased technology unit costs. Second, in an attempt to restrain military spending, the DOD has postponed new product acquisitions and instead has been upgrading existing weapons systems with improved avionics. The costs of electronic components are clearly rising relative to those of other inputs.

Other important commodities purchased by the aerospace industry include primary, nonferrous metals (for example, copper, aluminum, lead); radio, TV, and communications equipment; and scientific and controlling instruments.

The Government Market

Despite growing percentages of nongovernment and nonaerospace business, industry activity is still dominated by government contracts with the DOD and the National Aeronautics and Space Administration (NASA), a factor that has important effects on the industry's economic status. Preliminary sales figures for 2006 indicate that approximately $93 billion of the total sales were to these twogovernment agencies (see Table 1-2).

Defense Contractors The optimism that followed the breakup of the former Soviet Union was replaced by the reality of the Persian Gulf War in 1991 and what it signified: continued regional threats from various corners of the world. Fast on the war's heels came the conflict in the Balkans and an understanding that peace was equally threatened by European regional and ethnic tensions. Nonetheless, the military arsenals of the major powers clearly were too large once the possibility of conflict between the United States and the former Soviet Union was greatly diminished.

The process of adjusting to the post-Cold War era is still under way. The defense forces of the United States, its Western allies, and those of the former Soviet bloc nations are declining in size, nuclear arsenals are being dismantled, and the defense industrial bases of major Cold War players are shrinking and consolidating.

Leading up to the catastrophic events of 9/11, defense companies experienced decreases in business as a result of dwindling government contracts. Companies cut costs by trimming personnel at all levels. In the United States, aerospace sales to the DOD declined from a high of $61.8 billion in 1987 to $47.6 billion in 2001. Total employment fell from 1.3 million in 1987 to an estimated 794,000 at year-end 2000, largely as a result of defense

cutbacks. Military aircraft-related jobs declined from 656,000 in 1986 to 459,000 by year-end 2000. Despite the drops in business, defense companies impacted by a lesser number of contracts overcame the challenge of keeping key technical teams in place to maintain the technology capabilities on which the chances for future contracts rest. In 2006, business has picked up as a result of continued terrorism threats and political instability in the Middle East.

Companies are also focusing on improving their design and manufacturing processes and procedures, such as concurrent engineering and inventory control, to enhance productivity and competitiveness. They are restructuring by eliminating less profitable lines of business and adding new capabilities. Many companies are striving for greater balance between defense and commercial work, while others concentrate on the core defense business in which they are strong.

The industry continued its consolidation throughout the 1990s. The merger of Martin Marietta and GE Aerospace made Martin Marietta the largest defense electronics company in the world until the mid-1990s, when Lockheed purchased Martin. Lockheed went on to purchase the tactical aircraft business from General Dynamics, which significantly strengthened that company's positon as a leading producer of fighter aircraft. The purchase by Hughes Aircraft of the missile division from General Dynamics enabled Hughes to move into a joint lead with Raytheon in missile production and sales until Raytheon acquired Hughes's missile division. In 1998 Texas Instruments became a part of Raytheon. Later, Boeing acquired the Hughes satellite division. Other major acquisitions were the purchase by Loral of LTV's missile division and by the Carlyle Group and Northrop of LTV's aircraft division.

In addition to consolidation in the defense sector, some companies with existing civil and military product mixes are taking steps to expand their nondefense activities or to move into related areas. Boeing is allocating resources to its new 777 transport program. Raytheon purchased the corporate jet unit of British Aerospace to expand its commercial aircraft business. Textron purchased General Dynamics' Cessna Aircraft Company. But these were only the most sizable and newsworthy of many mergers and acquisitions as aerospace and related business divisions switched hands.

U.S. companies teamed up to perform R & D and to bid on government work. They are setting up joint ventures and other arrangements (sometimes including foreign partners) to apply technology developed for military purposes to commercial aerospace and nonaerospace markets. The anticipated growth of the civil aircraft business invites the application of technology to commercial avionics, air traffic control systems, and aircraft maintenance and upgrades.

Other civil business opportunities being sought include highway traffic management, the potential electric car market, hazardous waste and weapons disposal, high-speed data transmission, environmental sensing, space satellite communications, law enforcement (aircraft surveillance, "smart" computer-linked police cars, biosensing of drugs and bomb-making chemicals), large-screen television and home TV satellite service, software conversion, factory automation, light-rail systems, and cellular telephone systems. Although the range of new business is extensive, it will take time to develop markets. The amount of new business will not totally offset lost defense procurement dollars for years to come, if at all.

As companies deal with financial pressures, a smaller market, and uncertainty about DOD acquisitions, not surprisingly, R & D spending is down, as is capital investment, with few exceptions.

With the end of the procurement budget decline not yet in sight, defense contractors are more dependent on a balanced government–industry sharing of the work performed in government laboratories and service maintenance depots. Military exports are also more important both as a share of total defense sales and as an aid to preserving the technology and production base that keeps down the cost of defense systems for U.S. taxpayers.

NASA. The days of the Apollo program, when annual real increases in U.S. government space spending were the norm, are long past. The *Challenger* space shuttle disaster of January 28, 1986, and reduced spending on discretionary programs resulted in greater congressional scrutiny of civil space budgets. In addition, space efforts have been tempered by the diminished competition from the Russian space program and the end of the ideological competition between the leading capitalist and the major communist nations. The loss of the Space Shuttle *Columbia* on February 1, 2003, has led to further examination of space spending.

Yet many U.S. policymakers also recognize the importance of space from a technical, environmental, and commercial standpoint. As defense programs shed skilled workers, a healthy space sector is viewed as a mechanism that can reabsorb some of the talent that becomes available. In addition, the commercial segment of the industry, particularly telecommunications, has been a growth area in an otherwise troubled aerospace market. Environmental problems are receiving greater attention today, and the ability to monitor global warming, ozone depletion, and climatic changes from space is a valuable capability. A variety of space platforms are needed to meet these needs.

The cumulative effect of these opposing forces is a NASA budget that, while not declining, is also not showing any signs of real growth. Since 1990, NASA spending has been flat. In addition, some funds that once were earmarked for space programs will instead be shifted into aeronautical projects; the space station program will experience the greatest cutbacks. Consequently, U.S. government funding for civil space activities is not expected to rise significantly any time soon. Companies remaining in this business will have to be very skillful at selecting which space programs will demonstrate returns within a zero-growth NASA budget. This situation may prompt U.S. companies to seek foreign opportunities with greater vigor.

The Civil Aviation Market

The United States traditionally has been the largest market outside of the former Soviet Union for commercial transports, helicopters, and general aviation aircraft. Close ties between U.S. manufacturers and their domestic customers have provided U.S. aerospace companies with a solid sales base.

Although the domestic market will remain vital to U.S. aircraft programs, the economies of scale necessary for success in today's commercial market compel manufacturers to take an international approach. This is due to the fact that an enormous amount of capital is required to cover the development and tooling costs associated with a new program. For example, the cost of launching a commercial transport program today is approximately $5 billion. Manufacturers must wait about four years before deliveries begin and revenue is generated from their initial investments. Compared to other industries, the customer base for commercial passenger jets is limited and the volume of orders is low. Generally, between 400 and 600 aircraft must be sold before a program reaches the break-even point. These market characteristics also apply to other civil aircraft manufacturing sectors.

Consequently, every sale is important in order to pay back the nonrecurring costs of R & D and production tooling and to make a profit. This is why exports are an integral part of the product and marketing strategies of civil aircraft companies. Since 1990, foreign sales have accounted for over 70 percent of commercial transport and civil helicopter sales and about 40 percent of general aviation aircraft sales. Total civil aerospace exports reached more than $55 billion in 2005.

Civil aircraft manufacturers have had a global view for some time, as their export figures indicate, but recent changes in market conditions have increased the need for them to remain committed to an international strategy.

Air Transport. The principal civil aviation product is the airline transport. The traditional and obvious difficulty in this area is the fact that sales depend on the financial health of another industry—the world's airlines. The need for new jetliners is evident. The world transport fleet is aging, and the older, less efficient aircraft must be replaced. After reaching a high of 589 units in 1991, the number of shipments declined precipitously during the early 1990s as the economy went into recession and the airlines lost $13 billion during the first four years. The economy rebounded by the mid-1990s, and the orders poured in as the airline industry returned to profitability. The number of transport aircraft shipments reached a peak of 620 in 1999, when the industry recorded record profits. Once again, the economy slowed down in 2000 and fell into recession in 2001. The tragedy of September 11, 2001, exacerbated the decline, and the carriers lost $7.7 billion for the year. Transport aircraft shipments followed the decline during the first few years of the 21st century (see Table 1-3).

Before World War II, more than two dozen companies were in the business of designing and building large commercial airliners—large at that time meaning 20 seats or more—almost all for airlines in their home countries. Today, the number of prime manufacturers of large airliners—and that now means 100-plus seats—is down to two: Boeing and Airbus. In 1997, Boeing proposed a merger with McDonnell-Douglas for an estimated $14 billion. Although the proposed merger drew severe criticism from Airbus, it was approved.

The winnowing-out in this industry has happened for many reasons, the chief one being the cost of developing new aircraft. As one generation of aircraft has succeeded another, the costs of building the latest aircraft and designing its successor have risen exponentially. Combined with the uncertainties of the marketplace, the spiraling cost of development and early production of new aircraft has made the commercial aircraft business a risky venture.

Since deregulation in the late 1970s, the trend has been toward less and less differentiation within the airline industry as the airlines have competed more and more on the basis of price and schedule and as some of the oldest and proudest names in the industry have disappeared through merger or bankruptcy. In making their purchasing decisions, the airlines, in turn, have increasingly focused on a single factor: which of the various aircraft available to them in a few distinct categories is the low-cost solution to the task of carrying a certain number of passengers a certain distance? Each of the two major competitors strives to enter new markets ahead of the other by developing new and more cost-efficient aircraft, and each one tries to defend its markets in the absence of any natural barriers on the strength of being the low-cost producer.

Boeing has been able to maintain approximately 60 percent of the market for large jet transports in an increasingly competitive global market. The company's commercial

TABLE 1-3 Civil Aircraft Shipments, 1992–2006

	Number of Aircraft Shipped				Value (millions)			
Year	*Total*	*Transport Aircraft*[a]	*Helicopters*	*General Aviation*	*Total*	*Transport Aircraft*[a]	*Helicopters*	*General Aviation*
1992	1,790	567	324	899[b]	30,728	28,750	142	1,836[b]
1993	1,630	408	258	964	26,389	24,133	113	2,144
1994	1,545	309	308	928	20,666	18,124	185	2,357
1995	1,625	256	292	1,077	18,299	15,263	194	2,842
1996	1,662	269a	278	1,115	20,805	17,564e	193	3,048
1997	2,269	374	346	1,549	31,753	26,929	231	4,593
1998	3,115	559	363	2,193	41,449	35,663	252	5,534
1999	3,456	620	361	2,475	45,161	38,171	187	6,803
2000	3,780	485	493	2,802	38,637	30,327	270	8,040
2001	3,559	526	415	2,618	42,399	34,155	247	7,997
2002	2,893	379	318	2,196	35,000	27,574	157	7,269
2003	2,928	281	517	2,130	27,523	21,033r	366	6,124
2004	3,440	283	805	2,352	27,682	20,484	515	6,683
2005p	4,171	290	925	2,956	31,150	21,900	750	8,500
2006e	4,006b	400	650 NA		39,385b	30,200	685 NA	

Source: Aerospace Industries Association, based on company reports, data from the General Aviation Manufacturers' Association, and AIA estimates.
[a]Includes all U.S.-manufactured civil jet transport aircraft plus the turboprop-powered Lockheed L-100.
[b]Due to an unavailability of general aviation forecast data, 2006 totals include 2005 general aviation figures for the purpose of estimating.
e Estimate.
NA Not available.
p Preliminary.
r Revised.

transport products include the 737, 747, 757, and 767 models; the latest, the 777, entered service in 1995. Boeing's most formidable competitor has been and will continue to be Airbus Industrie. Airbus launched its first aircraft, the A300, just 30 years ago. By 1995, Airbus had captured approximately 30 percent of the worldwide market for commercial jet transports. Airbus's goal is to increase further its market share in the United States and abroad; the company's latest design, the 555-seat A380, which made its first flight in 2005, aims to see that this goal is reached.

Extensive levels of government subsidization by France, Germany, the United Kingdom, and Spain have enabled Airbus to develop a full family of aircraft without ever having made a profit, to price these aircraft without full cost recovery, and to offer concessionary financing terms to customers. Boeing and McDonnell-Douglas objected strenuously to this practice, claiming unfair competition. Airbus, in turn, claimed that Boeing and McDonnell-Douglas benefited over the years from the large military contracts that have offset a large part of their R & D expenses. In fact, the United States has long had a defense budget double that of Western Europe, with a large investment in military aircraft R & D and long production lines.

While both Boeing and Airbus were able to offer customers a full range of jetliners, McDonnell-Douglas was unable to. With a limited product range, McDonnell-Douglas dropped from being number two in the commercial aircraft marketplace in the late 1970s, with more than a 20 percent share of the total world backlog, to number three in 1995, with less than a 10 percent share. McDonnell-Douglas was subsequently purchased by Boeing.

The cost of developing new airplanes has become staggering. Every time a company like Boeing moves forward with a new program, it is essentially putting its entire net worth on the line. Enormous front-end investments must be made for a return that will not be realized until many years later—if at all. Boeing's program to develop and manufacture the 350-seat 777 airplane provided a good example of the enormity of the challenge. The company spent billions to develop the new airplane, which involves several thousand suppliers and over 800,000 different parts.

As Airbus and Boeing continue to compete, they are forced to develop new products and services that are attractive to an existing and potential customer base. Both manufacturers are going head-to-head on development of new aircraft technology that will revolutionize the future of air transportation. Airbus is launching the A350 in response to Boeing's B787 Dreamliner. Both aircraft are being developed with twin-engines capable of flying 250 to 300 passengers on long distance routes at costs much less than today's modern aircraft. Both aircraft will be light in weight consisting of composite materials amounting to significant decreases in fuel costs.

Although the cost of developing new airplanes is enormous, the cost of not moving ahead is even greater. A company's ability to maintain its position as a global aerospace manufacturer depends fundamentally on its capitalizing on new market opportunities. In instances in which the market is limited or the barriers to entry are prohibitively high for one company, international collaboration may be the wave of the future.

Although U.S. aerospace companies have dominated the global market for many years, the use of overseas suppliers of components and subassemblies is increasing. There is nothing strange about that, because two-thirds of the world market for large airliners exists outside the United States. Though companies in countries such as Italy and Spain have been major suppliers for many years, the nations of Asia and the Pacific Rim collectively have been distinctly minor suppliers. That is bound to change, for two reasons: those same countries already account for a substantial portion of the world market for commercial airliners (20 percent and growing rapidly), and they plainly have both the desire and the capability to participate in the production of new aircraft.

Unquestionably, international collaboration is a key strategy in the broader effort to remain competitive in the aerospace industry. Joint programs in which the partners share costs offer a means of generating the requisite capital for advanced commercial airplane and engine development in the face of high and rising costs. They also give the U.S. companies involved access to foreign markets that might otherwise be denied to them in view of the trend toward directed procurement. Offsetting these advantages to some extent is the fact that joint U.S.-foreign ventures inevitably strengthen the technological capabilities of foreign industry. In short, sharing American know-how might prove costly in the long run, because it further enhances the competitive posture of foreign companies. But sharing, it should be remembered, is a two-way street.

Factors Affecting Commercial Transport Sales

Continued market leadership of U.S. aircraft manufacturers is closely tied to the existence of healthy, profitable U.S. airlines. The huge size of the U.S. domestic market has been important to U.S. manufacturers by providing them with the broad base of demand necessary to launch new aircraft programs. Traditionally, over 40 percent of commercial jets on order from U.S. manufacturers have been delivered to U.S. airlines. These aircraft make up one-third of the value of the manufacturers' backlog of unfilled orders. Large

order volumes help manufacturers spread costs over a larger production run, which allows them to reduce their unit costs and be more competitive. Now more than ever, as they seek the export sales crucial to market leadership, manufacturers need the foundation of a strong U.S. sales base.

By the end of 1993, the airline industry was in a tailspin. Passenger and freight traffic was stagnant, aircraft by the hundreds had been placed in storage, industry losses and debts were mounting, and aircraft orders were being canceled. The downturn had also spread to the commercial transport sector, and aircraft manufacturers were forced to scale back production and lay off thousands of workers.

By 1997, however, the airline industry was taking off. Air traffic and profits were back up, and net orders for U.S. transports jumped from 256 in 1995 to 620 in 1999. The pace of this recovery left commercial aircraft producers struggling to keep up.

Civil aviation has a history of cycles, and with the slowdown of the economy in 2000 shipments began to tumble. Aircraft companies are implementing programs to reduce these market swings. Also, some economists are suggesting that business cycles in general should be less severe due to factors such as deregulation and global competition. Nevertheless, several factors strongly influence cycles in the air transport industry.

Economic Growth. Economic growth has a tremendous impact on the civil aviation market. It is important because it broadly influences the demand for air transportation services, which, in turn, affects aircraft orders and deliveries. During periods of economic growth, companies build and service new outlets, which leads to an increase in business travel. In addition, family incomes generally rise, which results in greater spending on leisure travel. Yet, the reverse is also true: when economic output falls, businesses close facilities, unemployment rises, and air traffic declines.

The correlation between economic growth and air travel has been recognized by analysts for many years. A generally accepted rule of thumb holds that there is a 2.5–3 percent increase in world air traffic for every 1 percent increase in world economic growth.

Inflation. Inflation is important because it influences economic growth. When prices are stable, interest rates tend to be low, and this encourages investment and business expansion. When prices rise quickly, interest rates also climb. Eventually, high interest rates will inhibit economic activity, which can put a damper on air traffic. Because high interest rates raise the cost of borrowing, they can also make aircraft financing prohibitive. In addition, inflation can result in escalating labor and fuel costs. When this happens, airlines are faced with the unpleasant choice of either absorbing those higher costs or raising their fares.

Inflation has grounded the airline industry on more than one occasion. In 1970, 1973, 1978, and 1991, air carriers faced rising fuel and labor costs. During those same years, inflation also plunged the major world economies into a recession, causing air traffic and airline profits to decline.

During the recent recessionary periods (1990–1994 and 2000–2002), air carriers sustained huge losses. Airlines have attempted to control their costs and have made it clear to aircraft manufacturers that they want the price of planes to come down. Aircraft companies have reduced their prices through implementation of long-term programs aimed at cutting costs and improving efficiencies, efforts that should benefit airlines well into the future.

Fleet Capacity. The passenger load factor is used to measure airline capacity utilization. The indicator is expressed as a percentage, relating the number of passengers flown to available seats. When load factors are low, airlines have more excess lift capacity than when load factors are high. High load factors and rising air traffic place airlines under pressure to buy aircraft. If load factors are rising during a business cycle, this also suggests that airline revenues are improving. This is important if airlines are planning to order aircraft because it enhances their ability to purchase or lease planes.

The passenger load factor for world airlines rose during the latter half of the 1990s, and orders for new aircraft reached record levels. Unfortunately, as was the case in previous economic downturns, air traffic declined in the early 2000s and load factors fell, prompting the air carriers to reduce fleet capacity and cancel orders. By year-end 2006, load factors were at "normal" levels and in some cases higher than ever.

Replacement Aircraft. Airlines order aircraft to increase their capacity; they also purchase new transports to replace their older, less efficient models. The advancing age of current fleets suggests that replacement orders should be on the rise through the mid to late 2000s.

In a related issue, the airlines were required to meet low stage 3 noise levels in the United States by December 31, 1999; the date in Europe was April 1, 2002. Although many of the over 3,000 aircraft have been grounded, modified using engine hushkits, or sold outside the United States and Europe, there is still a significant pent-up demand for replacement aircraft.

Airline Profitability. Commercial transports are expensive assets: smaller models start at approximately $25 million and jumbo jets cost over $140 million. To make these types of purchases, air carriers need to raise capital in the financial markets, and therefore, they need to demonstrate to potential investors that their operations are profitable. After losing billions of dollars in the early 1990s, the airlines returned to profitable operations in the latter half of the decade. Airline stocks were soaring and optimism prevailed as the carriers entered the new century. The economy slowed down in the spring of 2000 and went into recession in 2001, followed by the tragedy of September 11, 2001. Once again, the carriers experienced record losses in 2001 and 2002. US Airways filed for bankruptcy, and other major carriers were not faring much better. Massive employee furloughs took place during these years. United won $5.8 billion in wage and benefit concessions from its employees to stave off bankruptcy. By the end of 2002 the industry was in shambles. Over 90 percent of the passengers were flying on discount fares and low-cost carriers were eating away at market share from the old-line airlines.

With no retained earnings and stock prices at record lows, the carriers' only source of funds in the foreseeable future appears to be the debt market. This will not be an easy task because the carriers are already faced with a substantial debt load from the last round of aircraft purchases.

A Cyclical Industry. The civil aviation market is cyclical. This is important to recognize to fully understand the environment surrounding transport orders and deliveries. Since 1971, orders for U.S. transports have peaked five different times, and the average period between a trough and a peak has been three years. The delivery picture shows a similar pattern. World transport deliveries have peaked six different times since 1960. When deliveries have fallen, the declines have been steep (drops average over 50 percent);

nevertheless, deliveries have continued to rise over the long term. These cycles are set in motion by the underlying forces of economic growth and recession and are further magnified by the nature of aircraft manufacturing.

In the retail industry, items often sit on store shelves for weeks before they are sold, and buyers usually can take their purchases home the day they are bought. But aircraft are too expensive to build and then keep in inventory. Instead, they are manufactured only after an order is placed. This creates a time lag between order and delivery dates that can last well over a year.

Also, in the retail industry, there are many suppliers. If a customer has to wait for delivery from one supplier, that customer can go to another vendor offering a more immediate response. But again, the aircraft industry is different. Building a commercial transport takes an enormous investment, limiting the number of manufacturers in the business. If the order line for aircraft fills up, customers have little recourse but to wait.

If aircraft demand rises, manufacturers will initiate a new program or increase their production rates. Unfortunately, due to the tooling and supplier links that must be set up and the bottlenecks that can develop among strategically important suppliers, reaching full implementation takes time. For example, it took Boeing two years to double its production rate for all models.

These situations can create an imbalance between demand and supply that causes orders and deliveries to swing abruptly. Yet there is also a behavioral side to these cycles. Airlines and aircraft leasing companies worry that they might miss a market upturn if they are placed near the end of an ordering line. At the first sign of a market turnaround, they frequently scramble en masse to place orders. This creates a surge in orders that can push back delivery dates even further. As a result, air carriers near the end of the line might, in fact, receive their deliveries years later, as air traffic is subsiding. These deliveries then create an overcapacity problem, causing aircraft orders to swing downward. Manufacturers who had just invested in greater production capability now find themselves with excess capacity, and a shutdown reverberates through the industry.

These cycles are disruptive, and aircraft manufacturers are working to minimize them. Companies have launched efforts to shorten the product development phase and reduce the time gap between aircraft order and delivery. This is being accomplished by adapting computer-aided design and manufacturing technologies that obviate the need to build mock-ups. To improve program communication and efficiency, manufacturers are using concurrent engineering, which involves establishing teams of design, development, production, and sales people at the beginning of a program. Prime contractors are strengthening their relationships with their suppliers and increasing the two-way flow of technology. Boeing, specifically, is overhauling its production and systems software to simplify the way it tracks and handles millions of parts. Boeing also has reached agreements with American, Delta, and Continental that will provide those airlines with greater flexibility for ordering aircraft over a 20-year period. This will alleviate pressure on those carriers to order aircraft during a surge period.

Future Trends in Air Transport. The air transport sector has shown a strong tendency to recover from each downturn with renewed vigor. Economic growth and low inflation have been the key factors that have fed the demand for air transportation. This has pushed aircraft utilization to record levels, improved airline profits, and fueled programs to replace older aircraft. Together, these factors have contributed to a rise in aircraft orders.

Nevertheless, civil aviation has a history of cycles, and we can expect that orders and deliveries will fall.

Transport deliveries have been rising for the past 40 years. This suggests that deliveries will continue to climb in the future. In fact, transport manufacturers and analysts alike project that deliveries will almost double over the next two decades. The key assumption here is that the international economy will continue to grow.

General Aviation

After record shipments of 17,817 units in 1978, the **general aviation** segment of the aerospace industry, which manufactures light aircraft and components, experienced a 16-year downward slide in sales. After reaching a low of 928 units shipped in 1994, industry shipments increased for the remainder of the decade and through the years 2000 and 2001 (see Table 1-3). Historically, the economic cycle of the general aviation industry closely paralleled that of the national economy. This relationship changed during the 1980s and early 1990s. High aircraft prices, interest rates, operating expenses, and product liability costs all contributed to the downward cycle. Other analysts cited changing life-styles, tax laws, and foreign competition as further reasons for the sluggish sales performance of recent years.

The general aviation industry has undergone deep and broad structural changes. The major independent manufacturers have been taken over by conglomerates. Textron acquired Cessna from General Dynamics, and Beech is now Raytheon, taking the name of its parent company. Piper emerged from bankruptcy and is now operating as the New Piper Aircraft Corporation. While Raytheon and Cessna continue to concentrate on producing multi-engine and jet equipment, Cessna resumed production of several single-engine models in 1996 after a 10-year hiatus. This was largely in response to passage of the General Aviation Revitalization Act of 1994, which limited product liability suits involving older aircraft.

Business use of light aircraft remained strong despite the economic downturn in the 1980s, for several reasons. Small aircraft are fuel-efficient. In fact, they use less fuel per seat-mile than any other form of air transportation. A Boeing 747 gets 40.7 seat-miles per gallon of fuel (mpg); a six-passenger Piper Lance gets 89.4 mpg, the six-seat Beech Bonanza 86.4 mpg, and the seven-seat Cessna 207 84 mpg. Even light twin-engine aircraft perform better in terms of fuel usage than the extremely efficient Boeing 777.

Furthermore, airlines require considerable ground support facilities, such as tugs, shuttle buses, baggage trucks, and heated and air-conditioned offices and terminals, most of which use petroleum-based energy. Rarely is a major airline terminal as close to a person's ultimate destination as is a general aviation airport. Private-use aircraft can fly straight to their destinations, whereas airlines frequently use indirect routes with one or more stops along the way. This has been particularly true in recent years with the establishment of hub airports by the major carriers.

The efficient use of time is another reason general aviation will expand. As our energy problems deepen and the airlines seek to make more efficient use of costly fuel, it will be increasingly difficult to reach many locations via scheduled carriers. Only those routes that generate high load factors will continue to be viable, which means that the trend will be toward decreased airline service. Fewer than 5 percent of the nation's airports have airline service now, and the majority of flights serve only 30 major centers. It often is not possible using the airlines to travel in one day between such cities as New York and

Lexington, Kentucky; Chicago and Charleston, West Virginia; or San Francisco and Salem, Oregon. In the future, general aviation will be the only time-effective means of travel between many of the places business-people need to go.

The upward turn in units shipped and particularly dollar volume has ushered in a new wave of optimism to the general aviation sector. Unquestionably, general aviation is here to stay, but as in the air transport segment, manufacturers will continue to experience ups and downs with changes in the economic cycle, just as they have in the past.

To satisfy the need for public transportation, there will be considerable growth in the third-level, or commuter/regional, airlines, those operators who offer scheduled service in larger general aviation and short-haul transport aircraft. Commuter/regional carriers will link a number of small cities with low passenger volumes as the larger carriers concentrate their services in the high-density markets.

Helicopters. Sales of U.S.-manufactured civil helicopters continued to fall during the early 1990s (see Table 1-3). The helicopter industry's trade balance, positive through the 1980s, was negative through the early 1990s. (It should be noted that much of U.S. manufacturer Bell Helicopter's production is based in Canada and thus is not counted as a U.S. export when shipped abroad.) Today, lightweight, single-engine models dominate U.S. rotorcraft shipments, while French/German-owned Eurocopter is the largest manufacturer of larger, more expensive models. Overall, foreign manufacturers should continue to increase their share of the total world market even as U.S. manufacturers gain ground, as evidenced by the upturn in shipments since 1996.

Related Products and Services

Technology is simply knowledge, and it has a high degree of transferability: the know-how acquired in exploring aerospace frontiers can be put to work to provide new products and services of a nonaerospace nature, with resultant benefits to the economy as a whole.

For many years, the aerospace industry has pursued a program of technology transfer in an effort to make broader use of its wealth of know-how. The transfer process has been hampered by the lack of an aggregated market such as that provided by the federal government or the airlines in aerospace work. In nonaerospace activity, the industry has operated largely on a single-project, single-location basis, working with individual federal, state, and local government agencies and other customers to transfer technology in such areas as medical instrumentation, hospital management, mass transportation, public safety, environmental protection, and energy.

Despite the lack of an aggregated market, the results have been impressive in terms of industry sales volume, particularly in most recent years. In 1973, sales for related products and services topped $3 billion; but by 2005, they had reached approximately $28 billion (see Table 1-1).

THE AIR TRANSPORTATION INDUSTRY

The **air transportation industry** includes all civil flying performed by certificated air carriers and general aviation. Because this industry is the major focus of this text, it is important to define exactly what we mean by the terms *certificated air carriers* and *general aviation.*

The Civil Aeronautics Act of 1938 defined and established various classifications within aviation:[1]

> "Air carrier" means any citizen[2] of the United States who undertakes-… to engage in air transportation.[3]
>
> "Air transportation" means interstate-… transportation.[4]
>
> "Interstate air transportation"-… mean[s] the carriage by aircraft of persons or property *as a common carrier for compensation or hire.*[5] [Emphasis added.] No air carrier shall engage in any air transportation unless there is in force a certificate issued by the Civil Aeronautics Board authorizing such air carrier to engage in such transportations.[6]

Reading these sections of the act together, one sees the airline business as defined by Congress. The key words are italicized: *common carrier* and *compensation or hire.* Therefore, the appropriate term for airlines is not *commercial airlines,* but **certificated (common) air carriers.**

Having legally defined air carrier aviation, the act went on to define other types of aviation in a second category in the following way:

> "Air commerce" means interstate … commerce or any operation or navigation of aircraft within the limits of any Federal airway or any operation or navigation of aircraft which directly affects, or which may endanger safety in interstate air commerce.[7]
>
> "Interstate air commerce" … mean[s] the carriage by aircraft of a person or property *for compensation or hire-*… or the operation or navigation of aircraft in the conduct or furtherance of a business or vocation, in commerce-… between any State and any other State… .[8]

The first paragraph, which is all-inclusive and embraces all non-air carrier aviation, defines *general aviation* as we know it: noncommercial or *private* use. That paragraph is modified by the second one quoted, which goes on to define two subparts of general aviation: (1) *business* aviation, where the aircraft is used "in the conduct or furtherance of a business or vocation," and (2) *commercial* aviation, where people are carried for compensation or hire, but not as a common carrier—note that those words are omitted. Today, general

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[1]The language has been rearranged and certain words omitted for the purposes of clarity.

[2]A citizen may be an individual or a corporation.

[3]Section 101(3).

[4]Section 101(10).

[5]Section 101(2).

[6]Section 401(a) [Certificate of public convenience and necessity]. A common carrier is a person or company in the business of transporting the public or goods for a fee.

[7]Section 101(4).

[8]Section 101(20).

aviation is commonly described as "all civil aviation except that which is carried out by the certificated airlines." This segment of the industry will be covered in detail in Chapter 4, "The General Aviation Industry." Chapter 5 provides an in-depth review of the airline industry.

Contribution to the Economy

Over the past 60 years, the air transportation industry has become an increasingly important part of the U.S. economy. Aviation is the nation's dominant intercity mode of transportation for those passengers and goods that must be transported quickly and efficiently. It has become so universal that no one questions aviation's importance as an essential form of transport.

Aviation employs many thousands of people, and thousands more work in aviation's support industries, such as hotels, restaurants, rental cars, real estate, construction, and manufacturing. Individuals in these industries benefit economically from aviation regardless of whether they actually fly.

Aviation's final "products" are passengers and cargo safely and efficiently delivered to their destination. In 2004, U.S. airlines carried 698 million passengers and registered 28 billion ton-miles of cargo on approximately 9 million scheduled departures. U.S. airlines also carried more than 11 million passengers and over 6 billion ton-miles of cargo on approximately 400,000 nonscheduled departures. Although scheduled airlines provide service to about 800 communities, over 5,000 communities of all sizes can access the air transportation system via publicly owned general aviation airports, including nonscheduled, on-demand, and charter flights. The industry estimates that more than 160 million passengers are carried annually aboard general aviation aircraft and trends indicate this statistic is to increase over the next decade.

Most people are familiar with the aviation elements that they see and use—airports, airlines, and general aviation aircraft. They also might be familiar with some of the support elements—baggage services, travel agents, and others. However, the aviation industry is much more than that; it includes an intricate set of suppliers of a wide variety of goods and services, all of which benefit economically from aviation. With economic deregulation of airlines in the late 1970s, air cargo networks were able to facilitate just-in-time shipping, providing expanded services at lower costs. Optimization of just-in-time shipping allows short production and development cycle times and eliminates excessive inventory in the logistics chain, regardless of facility location. Without the availability of ubiquitous, reliable, efficient air express service, U.S. businesses would be unable to realize the competitive economies of just-in-time production. Air transportation offers many cost advantages—lower lead times, quicker customer response times, improved flexibility, and reduced inventory. Many high-tech, high-value industries have embraced air transport for its time and cost advantages in manufacturing and distribution and because it improves delivery reliability by providing time-definite guarantees.

One-stop shopping has become extremely important to businesses in their selection of logistics service providers and air cargo carriers. The ability to use a carrier that will provide door-to-door service with single-vendor control makes the entire logistics chain much less complicated than the traditional method of using several providers with different delivery functions. The major integrated carriers provide seamless trucking, warehousing, and distribution service functions in addition to air cargo. As a

consequence, shippers are increasingly substituting blended air and surface transportation services provided by (or through) a single carrier.

In July 2002, DRI-WEFA Incorporated in collaboration with The Campbell-Hill Aviation Group completed a study titled *The National Economic Impact of Civil Aviation.* As of early 2006, this is the most recent study. Using 2000 data, the study examined the impact of civil aviation, which included:

1. Scheduled and unscheduled commercial passenger and cargo operations (including cargo-only transportation)

2. General aviation (including business aviation and air taxi operations)

3. Their related manufacturers, servicing, and support (including pilot and maintenance technician training)

4. Their supply chains (indirect impacts)

5. The effects of income generated (induced impacts) directly and indirectly by civil aviation

6. The direct, indirect, and induced impacts of related industries, such as travel and tourism, for which air transportation provides an enabling function

Economic Impact Types and Causes. The aviation industry economic impacts calculated in the DRI-WEFA study included those financial transactions that could be traced to aviation and that were of value to the nation's economy and its citizens. The impacts were real and quantifiable; hypothetical, imaginary, or subjective impacts were not considered in the study. The impacts were divided into three types: direct impacts, indirect impacts, and induced impacts (see Table 1-4).

"Direct impacts" were those financial transactions linked to the provision of air passenger and air cargo services and the provision of aircraft. They typically occur at airports and aircraft manufacturing firms and include expenditures by airlines, airport tenants, air cargo firms, Fixed-Base Operators (FBOs), ground transport firms, flight schools, airport concessions, aircraft manufacturers, and others.

The direct impact in 2000 was $343.7 billion and 4.2 million jobs in civil aviation or in industries related to civil aviation, such as travel and tourism. Civil aviation, excluding related industries, directly produced $183.3 billion in GDP ($169.6 billion from commercial aviation and $13.7 billion from general aviation) and 2.2 million jobs.

"Indirect impacts" were those financial transactions linked to the use of aviation. They include expenditures by travelers who arrive by air, travel agents, business aviation, and others. Indirect impacts typically (but not always) occur at off-airport locations.

The indirect impact amounted to $254.9 billion and 3.2 million jobs arising indirectly in the other industries in the supply chain to civil aviation and related industries.

"Induced impacts" were the "multiplier" implications associated with direct and indirect impacts.

The DRI-WEFA study confirmed that virtually all activities involved in the provision and use of aviation are important to the nation's economy. The total economic impact of civil aviation, including its "multiplier" effect, was calculated as $903.5 billion for 2000,

TABLE 1.4 U.S. Civil Aviation Impacts, 2000 (billions of dollars and thousands of employees)

	Direct		Indirect		Induced		Total Impact		
	GDP	Employ-ment	GDP	Employ-ment	GDP	Employ-ment	GDP	% GDP	Employ-ment
Commercial aviation									
Air transport[a]	$100.1	1,172	$ 67.9	858	$ 85.7	1,035	$253.6		3,065
Aircraft	14.7	205	31.2	395	23.4	306	69.4		906
Aircraft parts	9.8	136	20.7	262	15.6	203	46.1		601
Airport expenditures[b]	38.0	437	na	na	19.4	223	57.4		660
Federal (FAA & NASA)	7.0	75	na	na	3.6	38	10.6		113
Total	169.6	2,025	119.8	1,514	147.6	1,805	437.1	4.4%	5,345
Expenditure related to commercial aviation									
Tourism by air	132.9	1,680	96.5	1,219	117.0	1,478	346.4		4,377
Travel arrangement	3.3	47	7.8	98	5.7	74	16.8		219
Freight forwarding	0.5	7	0.6	8	0.6	8	1.7		23
Total	136.8	1,734	104.9	1,326	123.2	1,560	364.9	3.7%	4,619
Commercial aviation, total	306.4	3,759	224.7	2,840	270.9	3,365	802.0	8.1%	9,964
General aviation									
Commercial operations	1.4	17	1.0	2	1.2	15	3.6		34
Private operations	8.9	104	6.0	76	7.6	92	22.6		272
General aviation aircraft	2.7	38	5.8	74	4.4	57	12.9		169
Flight training	0.7	19	0.4	5	0.6	12	1.6		36
Total	13.7	178	13.2	157	13.8	176	40.7	0.4%	511
Expenditure related to general aviation									
Tourism by air	22.9	290	16.6	210	20.2	255	59.8		755
Publications	0.6	7	0.4	5	0.5	6	1.5		18
Total	23.5	297	17.1	215	20.7	261	61.3	0.6%	773
General aviation, total	37.3	475	30.3	372	34.5	437	102.0	1.0%	1,284
Grand total	$343.7	4,234	$254.9	3,212	$305.1	3,802	$903.5	9.2%	11,248

Source: DRI-WEFA, Inc. Reprinted by permission of Global Insight (USA), Inc. www.globalinsight.com
[a] Air transport consists of all expenditures made by commercial airlines, including both passenger and freight, scheduled and non-scheduled, maintenance, and pilot and technician training.
[b] Airport expenditures consist of all expenditures made by airport authorities, including airport services.
Note: In 2000, total U.S. GDP was $9,873 billion. Because of rounding, totals and subtotals may not add precisely.

or 9.2 percent of GDP. Civil aviation including related industries represented 11.2 million jobs.

Commercial aviation accounted for 88 percent of aviation's total impact. Although general aviation accounted for only 12 percent of the total, it generated nearly 1.3 million jobs and $102.0 billion in economic activity.

Contribution to Efficient Conduct of Business

Air transportation is now as much a part of our way of life as the telephone or the computer. Speed, efficiency, comfort, safety, economy—these are the symbols of both modern society and modern air transportation. If you need to get somewhere in a hurry, and most businesses do, because time means money, then fly—comfortably, safely, and economically.

Air transportation has enabled employees of business and government organizations to reach any point in the world within hours, whether flying by air carrier or a general aviation aircraft. Certain values are associated with this timeliness:

1. Quicker on-the-spot decisions and action

2. Less fatigue associated with travel

3. Greater mobility and usefulness of trained, experienced executives, engineers, technicians, troubleshooters, and sales personnel

4. Decentralized production and distribution

5. The ability to expand market areas through more efficient use of management and sales personnel

To visualize a world without modern air transportation, consider the world of 1940, when surface transportation was still in its prime and air transportation was in its infancy. The 800-mile New York–Chicago trip took 17 hours each way on the fastest rail routing. The same trip today can be made in a couple of hours. Also consider the thousands of smaller communities now served by business representatives flying in and out the same day—it took days and weeks to cover the same territory back in the 1940s.

Impact on Personal and Pleasure Travel Patterns

In 1940, few people had ever flown in a scheduled airliner. By 1960, one-third of U.S. adults had flown; by 1981, two-thirds of the population over 18 years of age had been airline passengers, and by 2006, over 85 percent of the adult population had flown on a commercial flight. The impact of the air age on personal and pleasure travel has been at least as great as it has been on business travel. And airline fares remain a bargain compared to the price increases of other products and services over the past 50 years.

The combination of speed and economy has altered people's ideas about personal travel. In 1940, only a few wealthy individuals traveled to places like Florida or Hawaii, much less to Europe. Today, thousands of college students fly to Europe during the summer. Entire regions have developed into strong tourist-oriented centers because air

transportation has made them accessible to vacationers from many areas. The economic development of such areas as Florida, Hawaii, Puerto Rico, Las Vegas, Phoenix, and San Diego can be attributed to the access provided by air transportation.

KEY TERMS

aerospace industry
Aerospace Industries Association (AIA)
General Aviation Manufacturers Association (GAMA)
research and development (R & D)
related products and services
general aviation
air transportation industry
certificated (common) air carriers

REVIEW QUESTIONS

1. Define *aerospace industry,* and describe the role of both the AIA and the GAMA. The industry is a vital factor in four particular areas of the U.S. economy. What are they?

2. How has the aerospace industry changed since the 1950s? What are the unique characteristics of the aerospace industry?

3. Describe the aerospace industry in terms of its major products and its sales during the 1990s and early 2000s. What are related aerospace products and services?

4. What are some of the causes and effects of the significant downsizing in the two major segments of the government market? Describe the outlook for the civil aviation market in the early 2000s.

5. What is the primary cause for consolidation in the commercial aircraft manufacturing industry? Why has Boeing accused Airbus Industrie of unfair competition? What has been Airbus's response? How do you foresee the industry financing the new generation of aircraft that will appear in the 21st century? Why has there been a greater emphasis on international cooperation in building aircraft components and subassemblies?

6. List and briefly describe the major factors affecting commercial transport sales. How does the cyclical nature of civil aviation affect aircraft manufacturing?

7. What are some of the factors that led to the decline in general aviation aircraft sales? Why have the corporate and commuter segments of the general aviation industry done so much better than the personal-use segment? What is the outlook for helicopter sales?

8. Define *air carrier, interstate air transportation,* and *air commerce.* Both air carriers and general aviation fly "for compensation or hire." What distinguishes the two?

9. Discuss the impact of the air transportation industry on the U.S. economy in terms of dollar expenditures and jobs.

10. Describe the contribution of air transportation to the efficient conduct of business and its impact on personal and pleasure travel.

WEB SITES

http://www.faa.org
http://www.boeing.com
http://www.airbus.com
http://www.raytheon.com
http://www.airlines.org/home/
http://www.raa.org
http://www.iata.org

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