Chapter 4

TECHNOLOGICAL NEEDS AND OPPORTUNITIES

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INTRODUCTION

The appropriateness of a given aircraft depends on how well it matches the markets it is intended to serve. Commuter airlines typically operate on low-density, short-haul routes that create unique operational requirements: small passenger capacity, short stage length between stops, low-altitude operations, and high frequency of takeoff and landing at both small community airports and crowded major hubs. An additional constraint, since costs per mile increase rapidly as distances decrease, is that the number of seats that have to be filled to cover costs—the break-even load—is larger at short distances than at longer distances for a given fare structure.

Below certain payloads or stage lengths no aircraft can operate profitably. Although these boundaries can be lowered by increasing ticket prices or by reducing operating costs, each of these courses of action have their own limits. Fares per mile already tend to be higher at shorter stage lengths, and beyond a certain point further increases will decrease patronage and cause total revenue to fall rather than rise. Similarly, the turboprops flown by commuters have lower operating costs than the jets flown by trunks and locals; but at a given aircraft size and technological state of the art there is also a limit to cost reductions. At any given time, therefore, there will always be some short-haul markets, especially those enplaning a very small number of passengers, that cannot be self-supporting.

Lowering the break-even load of aircraft through improved technology, however, would make economically self-supporting air service possible at lower traffic levels. Other things being equal, this would mean that smaller communities would be able to support scheduled air service without subsidies.

The need for an "economic vehicle" that would enable commuter airlines to better serve this market segment is described by Fred Bradley of Citibank as follows:

> We are reasonably convinced that there is a large market out there, a lot of people that would fly on the commuter routes. And we've been approached practically daily on financing for this particular group of carriers. But as you go from airline to airline and look at their balance sheets and income statements, as you look at the numbers and analyze these airlines in some depth, which we have, the basic problem is that there really isn't an economic vehicle that will permit this particular group of carriers to operate profitably at this point in the type of business they're in.[1]

Similarly, the New York Department of Transportation has found that many commuters do not have the equipment to serve the State's short-haul markets: some cannot find the right aircraft, others cannot find financing; but in both cases the result is that commuter airlines do not have the means to enter existing and potential markets,[2] Commuter financing problems have been further aggravated by recent reductions in FAA equipment loan guarantees.

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[1]Fred Bradley, senior vice president, Airline and Aerospace Department, Citibank Corp.; proceedings of the OTA Advanced Air Transport Advisory Panel, Jan. 22, 1980, mimeo, pp. 34-35, 36, 66.

[2]Joseph Civalier, Aviation and Rail Planning Unit, New York State Department of Transportation, interview, June 24, 1981.

THE COMMUTER AIRCRAFT FLEET

When scheduled air-taxi service first developed in the 1950's and early 1960's, the fleet consisted primarily of older twin-engined Beech 18s (first flown in 1937), along with a few light twins and a variety of smaller single-engined aircraft. The low initial costs of these general aviation aircraft was important to carriers who typically operated with marginal financing and were willing to forego expensive passenger amenities in order to hold down their operating costs. As the industry grew and customer expectations rose, the airlines began to operate commuter derivatives of more modern executive aircraft, such as the Piper Chieftain and Cessna *402*.

The development of smaller turboprop engines, suitable for aircraft under 12,500 lb, led to the introduction of two extremely popular commuter aircraft, the 19-seat deHavilland of Canada Twin Otter in 1965 and the 15-seat Beech *99* in 1966 (heavier piston engines had limited earlier commuter payloads to about 10 passengers). The Swearingen Metro, a 19-seat executive derivative introduced in 1969, has sold well, with 100 now in service; this is the only current-technology aircraft presently produced in the United States for the 19-seat commuter market. The 18-seat Brazilian Embraer Bandeirante, introduced in 1972, has also gained considerable popularity with commuter carriers.

When CAB raised the size limit for commuter aircraft from 12,500 lb (about 19 seats) to 30 passengers in June 1972, many carriers preferred to stay with smaller aircraft (which better suited their needs and routes) in order to avoid the additional operating requirements. As a result, the commuter industry could not agree to endorse a 30-seat commuter aircraft and, lacking a firm domestic market, no U.S. manufacturer developed or produced a new aircraft in the 20- to 30-seat size range (see below). A few of the larger commuters did begin to operate larger aircraft on their denser routes, however, and the two foreign aircraft that were available–the French Aerospatiale Nerd 262 and the Shorts Brothers' SD-330, produced in Northern Ireland—captured most of the market.

The Airline Deregulation Act of 1978 raised the capacity limit again, first to 55 and later to 60 passengers, and once again commuter airlines that wanted to upgrade their fleets for high-density markets were forced to turn to foreign manufacturers. The only new commuter aircraft in the 30- to 60-passenger category was the Canadian-made deHavilland Dash 7, a four-engine 50-seat aircraft first flown in 1977; it has been put in service or ordered by a number of large commuters. Most of the commuters that wanted 30- to 60-passenger aircraft, however, had to settle for older, twin-engine planes—many also foreign-made—of the type once flown by the local service airlines: the British Aerospace **I-E-748** and Fokker F-27 (Dutch), both still in production; and two U.S.-built aircraft, the Convair 580/600 and the piston-powered Martin 404, both no longer in production. A few small jet aircraft, primarily Fokker F-28s and British Aerospace 146s, have also been purchased for operations in the densest commuter markets.

Fleet Mix

The current U.S. commuter aircraft fleet, broken down by manufacturer in table 5, is still

Table 5.—Commuter Aircraft in Joint Passenger/Cargo Operations 1980

Manufacturer	Piston single engine	Piston multi-engine	Turbo-prop	Jet	Heli-copter	Total all aircraft
Aerospatiale.	—	—	27	—	3	30
Beech	2	38	102	–	–	142
Bntten Norman	—	47	—	—	—	47
Cessna	104	181	—	—	—	285
Convair	—	9	30	–	–	39
DeHavilland	16	35	112	—	–	163
Douglas.	—	37	—	—	—	37
Embraer.	—	—	27	–	–	27
Fokker/Fairchlld.	—	—	19	5	—	24
Grumman	—	28	—	—	—	28
Handley Page,	—	—	16	—	—	16
Martin	—	20	—	—	—	20
Piper	53	264	—	—	—	317
Shorts Brothers	—	—	35	–	–	35
Swearingen.	—	—	103	—	—	103
Misc. Aircraft	3	9	9	–	5	26
Total all aircraft-.	178	668	480	5	8	1,339

Miscellaneous aircraft Aero Commander (9), Bell (3), Casa (2), Dornier (1), Hawker Siddley (l), Helio (2). Mooney (l), Nomad (5), Sikorsky (2)

SOURCE 1980 Commuter Airline Association of America Annual Survey dominated by relatively small aircraft. Piston-powered one- and two-engine aircraft seating less than 10 passengers account for 54 percent of all commuter aircraft.[3] Since deregulation, however, there has been a change in fleet mix: between 1978 and 1980, the number of small piston aircraft declined slightly, while the number of larger turbine aircraft almost doubled and average capacity rose to over 13 seats per plane. Ranked by the total number of available seats in the fleet, 7 of the top 10 aircraft have 15 or more seats and 4 of the top 10 have capacities of 27 or more passengers.[4] More significant is the fleet composition of the top 50 commuter airlines, which carry 87 percent of the industry's passenger traffic: two-thirds of their current fleet have capacities of 15 or more seats, and 60 percent of their orders for new aircraft are for 30 or more seats.[5] Most of these orders are for foreign-made aircraft.

Why Foreign Aircraft?

Commuter airlines cannot find the larger aircraft they want in the United States because American manufacturers have never developed a dedicated aircraft specifically for commuter use. In large part this is a lingering effect of the commuter industry's regulatory history (the Civil Aeronautics Board (CAB) 10,000-lb weight limit for air taxis in 1947, the 12,500-lb limit for commuters in 1969) and the industry's indecision when the limit was raised to 30 seats in 1973. These factors effectively killed the domestic market for commercial aircraft between the largest the commuters were allowed to fly (I9 seats) and the smallest the local service airlines wanted to fly (60 to 75 seats). In addition, the commuter aircraft market was extremely diversified, ranging from the smallest 4-seaters to the 19-seat limit, and was made up of numerous small companies that bought only one or two aircraft apiece. Manufacturers and other observers also cite the costs and uncertainties involved in Federal Aviation Administration (FAA) certification for new-technology aircraft. As a result, the current generation of U.S. aircraft in use by the commuters was developed primarily as passenger derivatives of more lucrative general aviation and business aircraft designs. But as one commuter operator puts it, "Old-generation equipment can't be modified to fit the new needs [and conditions]; we must have a new-technology plane to produce a profit. "[6]

Foreign manufacturers, on the other hand, continued to design and build new dedicated passenger aircraft in the 15- to *20-*, *30-* to 35-, and *50-* to 60-seat ranges for the European and Third World markets, frequently with government subsidies. They consequently had a considerable competitive advantage when CAB raised the commuter size limit to 30 passengers in 1973. U.S. manufacturers, apparently still considering the market too small and/or too risky, did not field a competitor in this size range until 1981—the 37-seat Gulf stream American G1-C, a stretched and refitted 1960's-generation executive aircraft. Similarly, when deregulation raised the commuter capacity limit to 60 passengers in 1978, the only American aircraft in the market were 20-year-old local service aircraft that were no longer in production. Foreign manufacturers, on the other hand, could offer the new 50-seat Dash 7 as well as older but serviceable aircraft like the BAe *HS-748* and Fokker F-27, which had been upgraded over the years and were still in production. One FAA official has put the situation this way:

> The thing that will strike you, if you go around and look at the commuters, is that the equipment that they're using is not built in the United States. With the exception of commuter-type aircraft, we lead the world, but . . . we have darned near by default turned this market over to foreign manufacturers. U.S. manufacturers are busy selling what they can make money on, and they don't think the commuter market is that big. If you go to Beech or Cessna or Piper, any airplane they're going to come up with is going to be a derivative. We're not seeing the utilization of new technology in these aircraft, but just the packaging of existing technology. They're not investing in real R&D—the

[3] Commuter Airline Association of America, *1980 Annual Report (Washington,* D. C.: CAAA, November 1980), p. 121.

[4] Ibid., p. 120.

[5] *Aircraft Convention News, vol. 12, No. 4,* July 1, 1980, p. 40.

[6] Angelo Koukoulis, president of AeroMech, interview, Aug. 4, 1981.

investment is too high for the number of aircraft in the market—so most U.S. commuter aircraft are old planes or modifications of general aviation. That's why commuter airlines are going to foreign airplanes—foreign manufacturers are subsidized in these smaller segments of the market.'

'Charles Foster, Director of the FAA Northwest Region, proceedings of the OTA Advanced Air Transport Advisory Panel, Jan. 22, 1980, pp. 18-19, 47; and interview, Jan. 19, 1981.

FUTURE MARKETS, AIRCRAFT, AND COMPETITIVENESS

In spite of consistently optimistic projections of the potentiaI domestic and international sales of commuter aircraft, most U.S. firms still appear reluctant to enter the market. Of the 15 or more commuter aircraft currently under development in the world, only a few are American and only one of these (Fairchild's SF-340, a joint venture with Sweden's Saab) represents an all-new design. This has in turn raised questions about the loss of the traditional U.S. aerospace technology lead and about the future competitiveness of the U.S. aircraft industry, not only in the international market but in the domestic market as well.

Market Projections

Forecasts of the future demand for light transport aircraft vary, but there is general agreement that considerable demand will in fact develop and that new aircraft in this category will find their initial success and major market with U.S. commuters airlines. The U.S. commuter fleet grew from 361 to 1,333 aircraft between 1965 and 1980, and the number of aircraft in the 21- to 50-seat range has increased 900 percent since *1972;* both trends can be expected to continue.[8] In a 1979 study conducted for the FAA, the Aerospace Corp. surveyed U.S. and foreign engine and aircraft manufacturers and trade associations, and arrived at a consensus 1980-2000 forecast of worldwide markets for 5,398 new aircraft between 15 and 60 seats, with the following breakdown:[9]

- 15 to 19 seats—800 to 3,750 aircraft, average 2,187 (48 percent in the United States);
- 20 to 40 seats—1,527 to 3,000 aircraft, average 1,996 (45 percent in the United States, plus a potential U.S. military market for an additional 200 aircraft);
- 41 to 60 seats—1,026 to 1,500 aircraft, average 1,215 (35 percent in the United States);
- total world market—3,353 to 8,000 aircraft, average 5,398 (44 percent in the United States);
- potential U.S. domestic market—over 2,500 new aircraft.

Whether this market would be large enough to support the development of new commuter aircraft by U.S. firms would depend on the market share they capture. As a rule of thumb, a manufacturer needs to sell at least 200 aircraft of a given model to recover its development costs, although high interest rates may raise the break-even point. In the 20- to 40-seat category, which the Aerospace Corp. report identifies as the principal equipment gap in the U.S. commuter fleet, 200 sales would represent only 13 percent and 30 percent of the lowest estimate of potential world and U.S. markets, respectively. Break-even sales would represent only 22 percent of the average forecast of the U.S. civilian market, and could be achieved through potential U.S. military sales alone.

A more recent report prepared for OTA makes an even more optimistic forecast of a total free-world market by 2000 for 6,250 new U.S.-manufactured commuter aircraft for airline and Government use, with the following breakdown:[10]

- 7 to 14 seats—1,650 aircraft (plus additional sales for corporate and private use);

'CAB Bureau of Domestic Aviation, *Memorandum on the Growth of the Commuter Carrier Fleet,* Feb. 10, 1981, pp. i, 4.

'Aerospace Corp., *Light Transport Aircraft Market Forecast,* prepared for the FAA Office of Aviation Policy, ATR-79(4857-03) -2ND, July 1979, p. 15.

[10]John W. Drake, "Estimates of U.S. Production of Light Transports for the U.S. and Foreign Market to the Year 2000," contractor report prepared for OTA, January 1980, p. 34.

- 15 to 19 seats—1,500 aircraft;
- 20 to 40 seats—1,600 aircraft (plus additional sales to the U.S. Government); and
- 41 to 60 seats—1,500 aircraft.

Aircraft Exports and U.S. Competitiveness

Exports of small transport aircraft have been increasingly important to both the industry and the U.S. balance of trade. Piper, Cessna, and Beech (who developed the light twin after World War 11 with almost no foreign competition) have until recently had a virtual world monopoly, and U.S. exports of new aircraft under 33,000 lb (about 50 seats) rose from $64 million in 1971 to $292 million in 1977. In 1979, U.S. general aviation manufacturers alone shipped almost 4,000 aircraft, valued at more than $600 million, to over 100 foreign countries. In the past these sales have been dominated by smaller single-engine, light-twin, and executive aircraft; but an equally large market may soon exist for commuter aircraft. Even the conservative 1980-2000 forecast above shows U.S. manufacturers competing for domestic sales of $5 billion to $10 billion and a total world market worth between $10 billion and $25 billion in 1980 dollars.

These numbers are large enough to constitute a viable market—in fact, a market large enough to attract many competitors, A growing number of developed and developing countries manufacture commuter aircraft in the 15- to 60-passenger range or have plans to do so (see table 6). There will be increasing competition for domestic and foreign sales in all three size categories, including sales tactics that some U.S. manufacturers characterize as "predatory financing. " Canada, for example, is the United States' principal challenger in this market, and the Canadian government has given deHavilland an $85-million loan to finance exports. This in turn allows the manufacturer to offer U.S. buyers up to 100-percent financing on orders for its forthcoming Dash 8 at 8-percent interest, and deHavilland has signed sales options with at least 12 of the 25 largest U.S. commuter airlines. Brazil, in an attempt to reduce its trade imbalance, imposes barriers to the sale of U.S. general aviation aircraft, but Embraer is able to market its Bandeirante and forthcoming Brasilia in the United States without restraints and with 85-percent financing at 8.5-percent interest. ' A recent agreement to reduce government aircraft export subsidies is restricted to jet aircraft and affects only the United States, France, Great Britain, and West Germany. [2]

Future U.S. competitiveness, particularity in capturing a larger share of the increasingly crowded *30*- to 40-passenger market, will depend on the ability and willingness of American manufacturers to efficiently produce low-cost, reliable aircraft that incorporate the latest cost-cutting and productivity-increasing technologies. Few of the commuter aircraft currently under development for production in the 1980's are American, however, and these tend to be derivatives of current-technology aircraft (see table *6).* Several commuter carriers have expressed concern that these new aircraft may embody many of the same compromises that make the current generation of U.S. aircraft less than optimal for low-density, short-haul operations. Many of these operators feel that a "family" of advanced-technology transport aircraft, spanning the 15- to 60-passenger range and meeting the cost and performance requirements of short-haul operations, will be needed if small communities are to receive good air service and if U.S. manufacturers are to meet foreign competition.

''*Aviation* Week *and* Space *Technology,* June 8, 1981, p. 103.

' 'See Nancy Ross, "4 Countries Reduce Subsidies for Aircraft, " *Washington Post,* Aug. 4, 1981, p. D6; and Clyde H. Farnsworth, "Accord to Limit Jet Export Subsidy, " *New York Times,* Aug. 4, 1981, p. D3.

Table 6.—Turboprop Commuter Aircraft Under Development

Manufacturer/model/comments	Origin	Seats	Speed (mph)	Estimated delivery	Price (millions of 1980 dollars)
Beech C-99 (B-99 derivative)	United States	15	290	Mld-1981	1.015
Dornier 228-100 (advanced-technology wing)	West Germany	15	268	December 1981	NA
BAe Jetstream 31	England	19	265	Mid-1982	1.6
Beech 1900 (Super King Air derivative)	United States	19	303	April 1983	1.6
Dornier 228-200 (advanced-technology wing)	West Germany	19	268	December 1981	1.5
Swearingen Metro III (Metro II derivative)	United States	19	305	1981	1.02
Ahrens 402/404	Puerto Rico	27-30	200	1982	1.7-2.0
Embraer Brasilia 120 (new PW1OO engine)	Brazil	30	345	May 1984	3.2
deHavilland Dash 8 (new PW1OO engine)	Canada	32	300	Mid-1984	4.0
Saab-Fairchild SF-340 (new GE CT7 engine)	Sweden/United States	34	315	Early 1984	3.75
CASA-Nurtanio CN-235 (new GE CT7 engine)	Spain/Indonesia	34-38	NA	Early 1985	NA
Shorts SD-360 (stretched SD-330)	Northern Ireland	36	215	1982	3.4
Gulf stream American GI-C (stretched used GI executive)	United States	37	345	1981	3.0
Commuter Aircraft Corp. CAC-1OO	United States	38-44	305	March 1984	3.0
Aerospatiale-AerItalia ATR-42 (new PW1OO engine)	France/Italy	42-49	300-315	October 1985	5.0

NA Not available.

SOURCE: Office of Technology Assessment

THE SMALL TRANSPORT AIRCRAFT TECHNOLOGY (STAT) PROGRAM

In 1978, the Senate Committee on Commerce, Science, and Transportation asked the National Aeronautics and Space Administration (NASA) to 1) identify technical improvements in commuter aircraft that would increase their operational economics and public acceptance; and 2) to determine whether NASA's aeronautical R&D programs could help aircraft manufacturers solve the technical problems involved in designing and producing an advanced-technology "economic vehicle" for use by commuter airlines.[13] NASA's final report and recommendations will be presented to the Committee in early 1982; preliminary findings are outlined below.

Through interviews with airline operators and engine and aircraft manufacturers, NASA's preliminary studies identified technological needs and opportunities in the following areas:

- Aerodynamics. —Reduce operating costs through improvements in cruise efficiency, second-stage climb performance, and takeoff and landing performance. Potential advanced-technology applications include airfoil and wing design for laminar air flow, new high-lift devices, improved engine/airframe integration, and rear-mounted configurations.
- Propulsion.—Improve engine fuel efficiency, reliability, and maintainability; reduce weight, noise, and initial cost. Potential advanced-technology applications include dual-phase turbines, electronic engine controls, and special materials for engine components, as well as high-efficiency propellers and other results of NASA's ongoing advanced-propfan research.
- Aircraft systems.—Improve safety, handling, and ride quality while reducing pilot workload and maintenance costs. Potential advanced-technology applications include fly-by-wire or fiber-optics controls, gust-Ioad alleviation technologies, low-cost icing protection, and improved navigation and guidance equipment.
- Structures.—Increase strength and reduce both weight and production costs through the use of advanced materials and manufacturing techniques. Potential advanced-technology applications include bonded-aluminum honeycomb, advanced aluminum alloys, and composite materials.

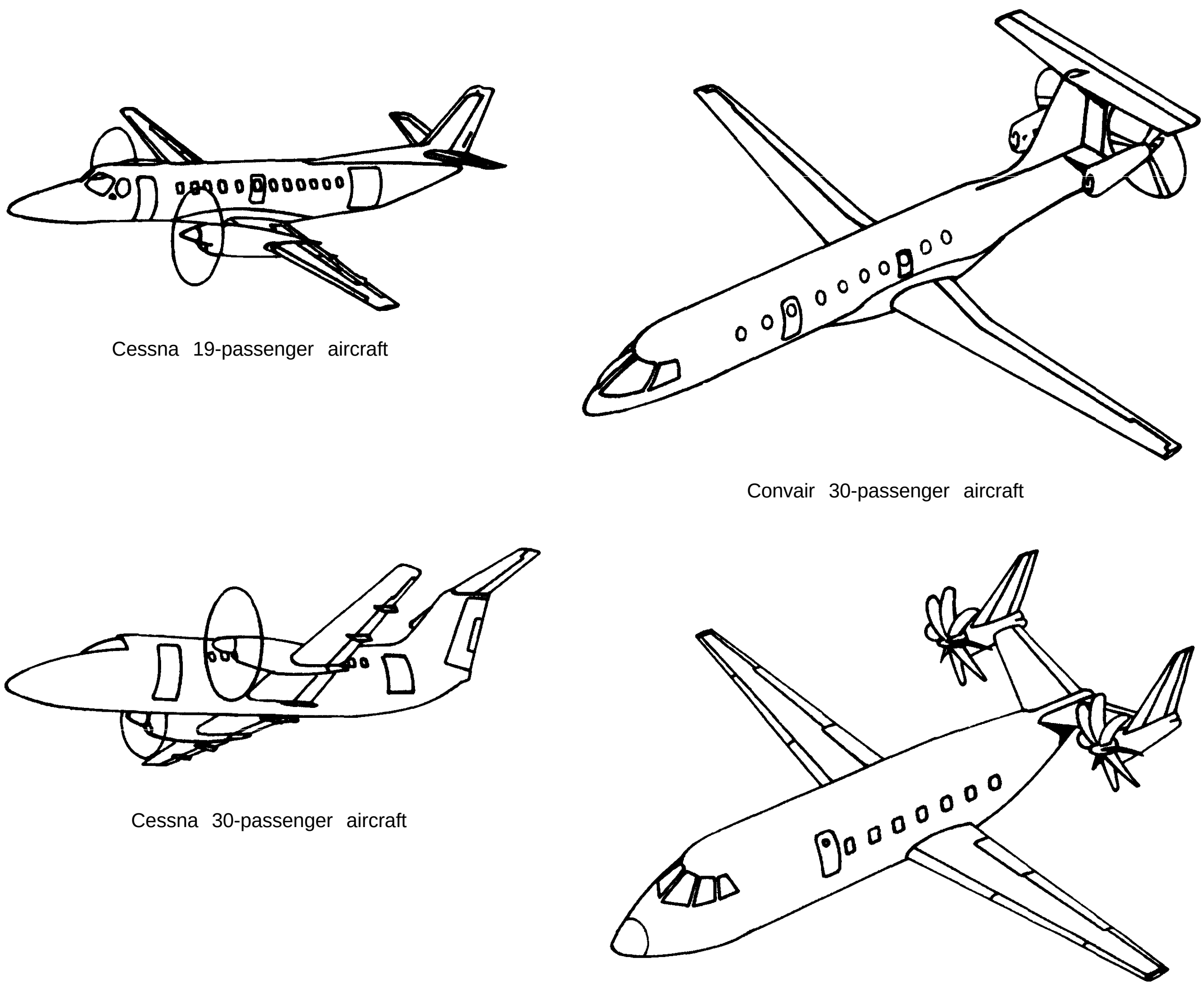
Based on these findings, NASA then commissioned technology-application studies by three aircraft manufacturers—Cessna, General Dy-

[13]Smul/ *Transport Aircraft Technology: An Interim Report for the Committee on Commerce, Science, and Transportation* (Washington, D. C.: National Aeronautics and Space Administration, October 1979), p. iii.

namics-Convair, and Lockheed-California—each of whom designed both a current-technology "base line" aircraft and an advanced-technology commuter aircraft in each size category (see fig. 7). Design goals included a range of 600 nautical miles with full payload, optimization for minimum direct operating costs over a 100-nautical-mile (nmi) stage length, 4,000-ft field capability, and passenger comfort (such as headroom, baggage space, pressurization, cabin noise, and ride quality) equivalent to large jet transports. Results included the following:

- Cessna's 19- and 30-passenger advanced-technology designs would use 38 to 40 percent less fuel on a 100-nmi trip and cut direct operating costs (DOC) by 21 percent (with fuel at $1/gal) compared to its baseline designs. Major improvements include the use of advanced propellers and engines, as well as structural bonding and compos-

Figure 7.—STAT Advanced-Technology Commuter Aircraft Configurations



Cessna 19-passenger aircraft

Convair 30-passenger aircraft

Cessna 30-passenger aircraft

Lockheed-California 30-passenger aircraft

SOURCE National Aeronautics and Space Administration ites that reduced aircraft weight and cost; the configuration is still fairly conventional.

- Convair's 30-passenger advanced-technology design would use 31-percent less fuel and reduce DOC by 24 percent compared to its baseline design on a 100-nmi trip. Major improvements include a new high-lift/low-drag wing design, composite structures, active controls, and improved propellers and engines, as well as a configuration with the engines mounted on pylons at the rear of the fuselage in order to reduce cabin noise and improve wing efficiency.
- Lockheed-California's 30-passenger advanced-technology design would cruise at Mach 0.6, 20 percent faster than the others, but would still save 26 percent on fuel and 16 percent on DOC compared to the company's baseline design on a 100-nmi trip. Major improvements include a high-lift/low-drag wing, active controls, improved propulsion system, and airframe manufacturing techniques that save 25 percent on structural costs compared to conventional aluminum skin-stringer techniques.
- Additional engine studies conducted by Allison, General Electric (GE), and Garrett indicate that opportunities exist to save about 20 percent on fuel and 13 percent on direct operating costs relative to current-generation turboprops, or 12 and 8 percent (respectively) relative to the new generation of fuel-efficient engines to be introduced about 1982 (i.e., GE's CT7 and Pratt & Whitney Canada's PW1OO families). Similar propeller studies by McCauley and Hamilton-Standard indicate that additional improvements of 8 to 17 percent on fuel and 3 to 8 percent on DOC are possible with advanced propeller technology, depending on baseline and configuration. (These engine and propeller results were assumed in the foregoing airframe company results.)

The findings of the STAT program to date indicate that very significant improvements in fuel efficiency, operating costs, and passenger comfort are possible in future commuter aircraft through a combination of technological advances, and that NASA's current large-transport and general aviation activities will contribute to some of the necessary technical improvements. However, not all of the possible spinoffs are directly applicable to commuter aircraft, whose design constraints and operation requirements present significantly different research and technology problems.

Proposed NASA Technology-Readiness Program

The special Commuter Air Transport Subcommittee of the NASA Advisory Council's Aeronautics Advisory Committee recommended in November 1980 that NASA sponsor a dedicated R&D program to bring the necessary specialized technologies to a state of readiness for commercial development and application. The resulting STAT technology-readiness program, as outlined in the draft final report, consists of four major subprograms (each with small, medium, and large options) that would bring their respective technologies to different levels of readiness: [4]

- Propulsion—
  - Small: 3 years, $6 million.
  - Medium: 4 years, $24 million.
  - Large: 5 years, $35 million to $70 million.
- Structures—
  - Small: 3 years, $6 million.
  - Medium: 4 years, $16 million.
  - Large: 6 years, $20 million to $30 million.
- Aerodynamics—
  - Small: 3 years, $3 million.
  - Medium: 4 years, $7 million;
  - Large: 5 years, $10 million to $15 million.
- Systems—
  - Small: 3 years, $3 million.
  - Medium: 4 years, $11 million.
  - Large: 5 years, $15 million to $20 million.
- Total STAT readiness program—
  - Small: 3 years, $18 million;

[4] National Aeronautics and Space Administration, Small *Transport Aircraft Technology,* draft report of the Aeronautics Advisory Committee's Ad Hoc Subcommittee on Commuter Air Transport Technology, Dec. 22, 1980. See also Louis J. Williams (NASA-Langley) and Thomas L. Galloway (NASA-Ames), "Design for Supercommuters, " *Astronautics and Aeronautics,* vol. 19, No. 2, February 1981, pp. 20-30.

Medium: 4 years, $58 million;
Large: 5 to 6 years, $80 million to $135 million

The response to these draft proposals from commuter operators, aircraft manufacturers, and aviation officials familiar with the details of the STAT program varies considerably. One successful commuter operator has said that STAT could be very important to marginal cities that might otherwise lose their air service, and that he would like to be able to buy such aircraft from U.S. manufacturers—"It tears you apart to go overseas. "[15] Other commuter operators agree but add that NASA should be looking at faster aircraft (400 mph propfans rather than 300 mph turboprops) optimized for longer routes, since the average commuter stage length has already risen to 120 miles and will probably rise to 200 miles with the end of 406 subsidies.[16]

The Senate Committee on Commerce, Science, and Technology has indicated that NASA should also look at the requirements of low-density, long-haul routes. [17] Small aircraft of this type might be profitable in nonhub-to-nonhub markets, and larger aircraft on routes between medium hubs (see ch. 3). One U. S. firm, DuPont Aerospace, has announced plans for an innovative 30- to 45-passenger twin-jet for such routes, but other sources think that turboprop or propfan propulsion would be preferable on routes up to 1,000 miles. Another domestic manufacturer contends that the major market opportunity after 1985 will be for larger turboprop aircraft—60 to 100 passengers—on regional routes of up to 850 miles. 'e Several major airlines have also indicated that they might consider buying a larger 150-seat turboprop or propfan, if the technology is successfully demonstrated and the aircraft economically produced.

Other observers, however, point out that time is crucial: initial orders lead to follow-on orders, and markets lost to foreign manufacturers may be irretrievable, They therefore recommend that the STAT program be accelerated or simplified in order to produce short-term results that can be applied quickly by U.S. manufacturers. Particular priority has been given to the aft-mounted engine configuration, for instance. One industry expert has suggested that the quickest, cheapest, and most useful thing NASA could do would be to rear-mount existing turboprop engines on an existing airframe for aerodynamic and cabin-noise tests.[19] A NASA official involved in the STAT program agrees that configuration and aerodynamics are perhaps the highest priority and that such a test-bed aircraft, for checking the tradeoffs with different wings and engine mounts, would be desirable "not too far into the program. "[20] Others stress the need to evaluate the performance of propfan engines on this test-bed aircraft. Gulfstream American, which is eager to stay in the commuter market, has already offered NASA the wind-tunnel models of its G2 and G3 executive jets for use in tests of the aft-mount configuration. Fairchild and Cessna are also interested in the configuration, as are Aerospatiale, Fokker, and Saab among foreign manufacturers.

A far more fundamental question with regard to the proposed STAT readiness program, however, was raised by the chairman of the NASA advisory committee that reviewed it: "would an increased flow of new technology from NASA as a result of conducting research in applicable areas, in fact, be *used* by the U.S. aircraft industry in developing a new commuter aircraft?"[21] Industry representatives have been pessimistic until recently, in part because of market condi-

' 'Angelo Koukoulis, president of AeroMech, interview, July 10, 1981.

"Dick Henson, president of Henson Aviation (Allegheny Commuter), interview, June 23, 1981; Ken Cardella, president of Cochise Airlines, interview, June 24, 1981.

"U.S. Senate, Committee on Commerce, Science, and Transportation, "National Aeronautics and Space Administration Act, 1982, " Report No. 97-100, May 15, 1981, p. 37.

"James J. Foody, vice president for aerospace development, and Samuel C. Colwell, director of market planning, Fairchild Industries; interview, June 15, 1981, and private communication, June 17, 1981. See also their "New Horizons for the Turboprop in Airline Service" and "Role of the Turboprop in the Air Transportation System for the 1980's and Onward, " mimeos, n.d.

"James J. Foody, vice president for aerospace development, Fairchild Industries, interview June 15, 1981.

[20]Louis J, Williams, head of the General Aviation and Commuter Technology Office, NASA Langley Research Center, interview, June 26, 1981.

"Robert J. Loewy, chairman of the NASA Aeronautics Advisory Committee, letter to Walter J. Olstad, NASA Acting Associate Director for Aeronautics and Space Technology, Mar. 26, 1981; emphasis his.

tions; but several NASA officials feel that there is every indication that U.S. manufacturers will in fact use the technology once it is brought to sufficient readiness. In a sense they would have to do so, in order to remain competitive in an increasingly crowded market. The initial advantage would accrue to U.S. firms who participate in the NASA research activities, but the results would eventually become available to their foreign competitors, many of whom are already actively pursuing these technologies: Dornier is using advanced-technology wings, composites, and manufacturing techniques in its new 228/100 and 200; Aerospatiale and Aeritalia are applying advanced aerodynamics, active controls, and propellers in their ATR-42; and there are indications that Japanese firms like Mitsubishi may soon begin work on advanced turboprop commuter aircraft.

Beech, Cessna, Fairchild, Gulfstream Amercian, and Lockheed-Georgia have all expressed an interest in the STAT program and a willingness to apply at least some of the technological improvements it might produce. The revolutionary Lear Fan executive propfan, and the recent advances in U.S. business aircraft technology generally, indicate that U.S. firms can and will apply advanced technology aggressively in order to remain competitive in a lucrative market segment. Nevertheless, there are significant barriers to the development of a family of advanced-technology commuter aircraft in the United States. One such barrier is financing the necessary R&D: another is the delay and costs arising from an uncertain FAA certification process; a third is the financial risk inherent in competing with Government-assisted foreign manufacturers. Some observers believe that a well-funded, well-designed STAT program would encourage manufacturers by demonstrating Government support for their attempts to develop and certify new commuter aircraft. These issues, as well as the more specific issue of how to ensure that STAT's advanced technologies will actually be used by U.S. manufacturers, still remain unresolved.

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