BEECH 1900
DESIGNING FOR DISPATCH

BY EDWARD G. TRIPP

Back in the good old days, there were several companies that built airplanes for individuals, companies, the military and airlines. Stinson, Fairchild, Northrop, Lockheed, Ryan, de Havilland and Sikorsky are some of the companies that come to mind. Then came the time when most manufacturers became more specialized, some concentrating on "little" airplanes and others on airliners and warplanes.

From the user viewpoint, many air carriers began with what we would today call general aviation or light airplanes. That is still somewhat true to this day, although yet another category of airplane, loosely called commuter aircraft, has come into being. This is not to ignore the many designs that did yeoman service as air taxis and commuters such as the Cessna 402 and 404, the Piper Navajo and the Beech 18.

Then, too, U.S. general aviation manufacturers have designed airplanes specifically for airline operations, such as the Beech 99 (introduced in 1968, an improved version, the C99, continues to be offered) and modified other models in order to provide more reliability and maintainability—dispatchability—that the frequent cycles and higher utilization of revenue passenger and freight-hauling operations demanded. Three examples of models modified for freight hauling are the Piper T-1020 and T-1040, based on the PA-31 Navajo/Cheyenne design, and the Fairchild (Swearingen) Metro, a stretched version of the Merlin.

There have been other design studies for commuter aircraft in the United States. For instance, in 1956 Cessna flew its model 620, an up-to-11 passenger, pressurized airplane powered by four 340-hp Continental GSO-526 engines. In 1968, the Piper PA-35 Pocono, a wide-fuselage design for up to 17 passengers made its first flight. It was powered by two 500-hp Lycoming TSIO-720 engines. Neither project was certificated, although it is thought that the Pocono might have been successful if turboprop powerplants had been used.

For a number of reasons, U.S. manufacturers did not see a big enough market for commuter aircraft to warrant development expense. The day of the commuter air carrier had been heralded for a long time—starting in the 1950s—without much result. Most small air carriers were financially weak, and financial institutions did not consider the business stable enough to provide the funds needed to expand existing carriers or start new ones. Regulations were and are complex and affected the size, operational limitations, crew requirements and labor costs, and design

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features, including safety systems, number of seats and performance.

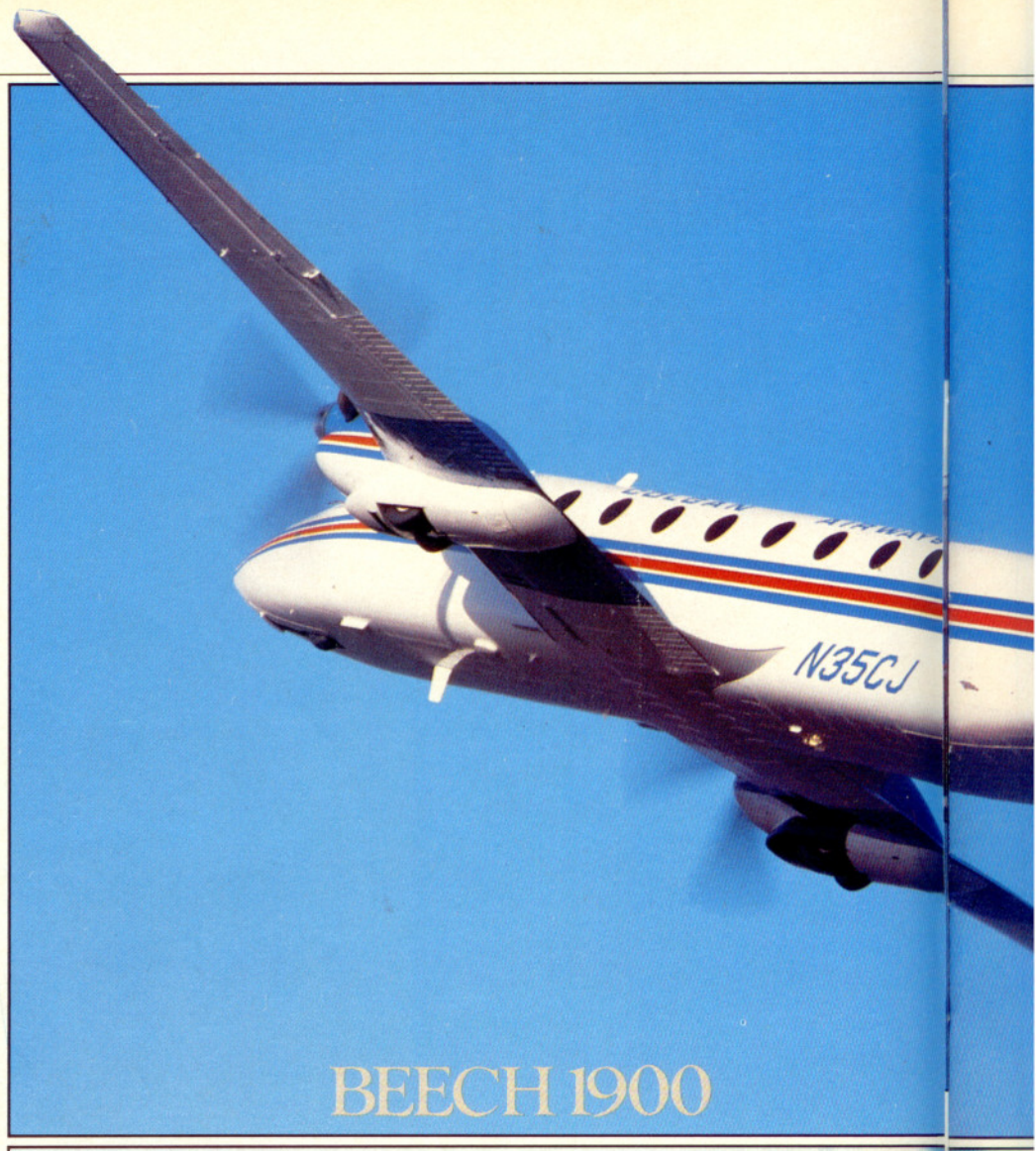
Aircraft industries in other nations did see an attractive market. Airplanes from Canada, Northern Ireland, Scotland, Spain, Indonesia, England, Brazil and Australia, frequently helped by liberal financing programs, began to dominate the fleets of small carriers in the United States, particularly in the up-to-19-seat category. (Aircraft with higher capacity are subject to even more stringent certification, operation and reporting requirements. These larger aircraft are now the subject of another international design and sales competition.)

Deregulation of the airlines gave impetus to the growth of commuter air carriers (the preferred designation has become regional, rather than commuter, in an effort to upgrade the image and further separate the commercial enterprise from its general aviation roots and align it more closely with what were traditionally considered the trunk, or major, air carriers). That growth also spawned significant job opportunities for young, relatively inexperienced pilots.

Beech had suspended production of the 15-seat B99 in 1975, but in 1979 the company decided to reenter the commuter business in earnest. It announced plans to produce the C99 and disclosed design studies for a 13-passenger, pressurized 1300 (a commuter version of the King Air 200); a 19-passenger, pressurized 1900; and a 35-seat airplane. Of the latter three airplanes, only the 1900 became a reality. It first flew on September 3, 1982, and was certificated in November 1983. The first delivery was made in February 1984.

The 1900 is a development of the King Air 200. The family resemblance, even in the cockpit, is obvious. It is certificated under an amendment to the B200's Federal Aviation Regulation Part 23 approval plus the requirements of special FAR 41. More than 3,500 King Air and military variants have been produced since the introduction of the series in 1964. Beech applied what it has learned from customer service experience of the King Air and the 99 and carefully considered the economic, regulatory, operational and maintenance factors that rule the fortunes of commuter operators.

Economic considerations involve much more than initial price and hourly operating costs. Both are impor-



BEECH 1900

tant, of course. The price of the 1900 is higher than competitive products, particularly when some of the liberal financing plans that other manufacturers offer are factored into a purchase evaluation. But the earning ability of an airplane over its useful life is more important to the sophisticated prospect.

Earning ability includes evaluation of seat/mile costs, break-even load factor (how many seats or how much cargo load must be sold to cover direct operating costs or, even better, the full cost, including debt and overhead), passenger appeal, maintenance costs and reliability (or dispatchability).

In fact, in the for-hire carriage business, everything gets down to economics. How many seats can be filled on a hot day at high elevations? Will the airplane perform to the minimum requirements of operational regulations for a given airport? How frequently do things break or systems fail? If something fails, can the airplane still be flown in revenue operations? How many people does it take to operate and maintain the airplane and the systems? Can it be filled with passengers and baggage within weight and center-of-gravity limits for a variety of stage lengths? How much special support equipment is required?

Commuter operations are mostly short stage length, high cycle ones. Doors are opened and closed, aisles walked on, engines started and stopped, gear raised and lowered, electrical systems turned on and off, many times a day. If the loads are there, the more hours per day an aircraft can be flown for hire, the better. If a development route is a factor and a schedule must be kept to attract future business, the fewer seats that must be filled to cover all costs, the better. And the airplane had better be able to do it for two or three thousand hours each year.

The Beech 1900 is an interesting response to the complex considerations that commuter airline managers must analyze before specifying the types of aircraft their lines will operate. It is a fairly large, constant-diameter, semi-rectangular tube into which a maximum of 19 passengers can file and seat themselves in about the same amount of space as the trunk airlines offer back in coach. There is a hanging locker in the forward cabin and room for small carry-on luggage under each seat. The cabin is pressurized to a maximum pressure

differential of 4.8 pounds per square inch (cabin altitude at the maximum operating altitude of 25,000 feet is 10,500 feet). In addition to bleed air heat for the cabin, there are dual freon air conditioners.

The original layout installed airstair doors at the forward and aft ends of the fuselage, but the 44 aircraft delivered to date are equipped with a large baggage door and a 154-cubic-foot baggage bay at the aft end of the fuselage. Only the forward airstair door remains for passenger boarding.

The Beech 1900 was designed for load flexibility. The center of gravity range is sufficiently wide to permit operations within limits with full fuel and crew without exceeding forward limits, or maximum passengers and baggage and not exceed the aft limits. At a typical equipped operating weight, including two crew members, of 9,040 pounds, the maximum ramp weight of 16,710 pounds allows full fuel (425 gallons/2,847.5 pounds usable) and 4,822.5 pounds of payload. The high payload capacity and wide CG range afford both economic and operational flexibility, and reduce the pressure to fudge that frequently confronts ramp agents and flight crew in commuter operations.

BEECH 1900

The wide CG envelope could have been achieved with a larger tail, but that would have increased empty weight and reduced payload. It could have been achieved with a mechanical or electronic stability augmentation system, but that would have affected dispatch reliability because it would have to be a no-go item or severely limit loading options.

These and related design and operational issues were resolved aerodynamically. Stabilons, tailets and vortex generators provide natural, or aerodynamically acceptable, handling characteristics throughout the envelope.

The stabilons are secondary, fixed horizontal tail surfaces mounted on the tail cone. They enhance pitch stability throughout the operational range of the 1900 and improve stall and stall-recovery characteristics.

The tailets are vertical surfaces hung from the bottom of the main horizontal stabilizers toward the outer edges. They are positioned out of any disturbed airflow from the wings and fuselage, particularly at high angles of attack, to improve yaw or directional stability. The tailets are sufficiently effective so that the standard equipment yaw damper is not a no-go item.

The vortex generators on the 1900 are fixed devices mounted on the fuselage forward of the leading edge of the wing root. They improve stall characteristics, including directional control, and thus help reduce the stall speed. They also reduce drag at the wing/fuselage junction.

The stabilons and tailets are made of composite materials, as are the four-bladed propellers, and are the largest composite elements Beech has used on an airframe.

These aerodynamic devices also eliminate the need for stick shaker or pusher devices for stall warning and recovery. Thus, other potential no-go items have been eliminated.

Many other elements of the 1900 have been designed to minimize no-go items, maintenance and weight, and to increase durability.

Maintenance access to systems is good. Wherever possible, systems are grouped to minimize the number of access panels that must be removed to inspect or repair. Non-skid paint, rather than an adhered, screwed or riveted non-slip surface, is used on the airstair door steps. It will not come loose and is easier to replace.

The landing gear is not enclosed

BEECH 1900

with full doors when retracted. There is less to get out of adjustment and less to maintain, especially considering the many cycles per day and the high (180-knot) gear operating speed.

In the cockpit, all instruments are front-mounted. It may not be as pretty as a typical corporate panel, but faulty instruments and gauges can be removed and replaced quickly.

It is a big, heavy airplane as commuters go, but pilots will find it makes their lives easy. A type rating is required (Beech provides crew training), and airline service requires two flight crew. But it is approved for single pilot operation under Part 91 regulations.

The cockpit arrangement and systems are typically King Air, which are well-organized to minimize crew work load. Pilots making the transition from King Airs will find it a pleasant, familiar environment. Pilots making the transition from other commuter airplanes will "...think they have died and gone to heaven," in the words of one commuter pilot.

In the airline version, which currently sells for $2.9 million, equipped to be put into service immediately (with all avionics and weather detection and protection systems required, including bleed air brake deice), the 1900 is not equipped with flight directors or autopilots. This is not just a price consideration, it is even more importantly a dispatch reliability issue: minimize the no-go items.

In my brief flights, I thought the 1900 was easier to fly than any of the King Airs. In the short stage lengths that are typical of commuter operations, and with two crew, such niceties as autopilots will not be missed. That says a lot for the airplane.

I flew with Chester J. Schickling, Beech sales manager for airline products. We devoted our flight time to slow flight and high task load situations. For instance, we simulated operations at small airports and jet penetration-type arrivals and departures at high density airports.

At maximum takeoff weight of 16,600 pounds, the 1900 can clear a 50-foot barrier in 3,250 feet from brake release and land in 2,540 feet. Stall speed clean is 101 knots; in landing configuration, 88 knots.

The first notch of flaps can be lowered at 198 knots, the gear at 180 and full flaps at 153. This makes the 1900 capable of mixing in easily with heavy jet traffic and can expedite approaches to smaller fields.

Throughout all the profiles, including loitering and doing airwork at maximum speeds and high task departures and approaches, the airplane was surprisingly easy to handle. Control forces are light for so much mass and weight. All of this translates into comparatively easy work loads for the flight crew and unruffled trips for the passengers.

At typical cruising altitudes (from 12,000 to 15,000 feet), the 1900 will cruise at just over 250 knots for an IFR reserve range of more than 600 nm.

Beech has just delivered the first two executive versions of the 1900, which will be used as corporate commuters, and 56 have been sold to airlines, to date. The commuter market is one of the few relative bright spots for airframe manufacturers. For instance, Fairchild Aircraft has increased the production rate for the Metro III, its 19-seat competitor, twice this year.

The dispatch reliability, maintainability and good flying qualities designed into the 1900 should provide good lessons learned for other designs, including, one hopes, a family of smaller Beechcraft. □