B/CA Analysis: Gates Learjet 55

Gates Learjet enters the medium-jet market with an evolutionary aircraft that features a "standup" cabin and proven Learjet systems.

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Just as the Model 23 Learjet launched the modern age of corporate flying when it was certificated 17 years ago, certification and first deliveries of the Model 55 mark the beginning of a new era for Gates Learjet, the world I s most prodigious producer of corporate jets.

The Model 23 and its more refined derivatives, the Models 24, 25, 35 and 36, have been well received by the business community. Although somewhat small by heavy-iron standards, with cabin lengths ranging from 9.0 to 12.9 feet but height limited to 4.3 feet, the high-flying speedsters satisfy businessmen who apparently are willing to trade an attractive price performance ratio for less than airline size accommodations. At Learjet speeds, many miles can be covered in the 1.3 hour flight that until recently represented the average trip in a business aircraft; thus cabin size has not been a primary consideration among the majority of Learjet operators.

But corporate aviation has matured over the past 17 years, with significant changes occurring since the Airline Deregulation Act of 1978. Average trip length has moved upward, as have utilization and load factors. In 1975, for example, the average usage of a turbine aircraft in corporate aviation was 350 hours per year; by 1980 utilization had increased to 430 hours annually and it is estimated that usage will be 580 hours per year by 1985. The average load factor for corporate turbines grew from 2.3 in 1975 to 3.6 in 1980, and it is forecast to reach 6.5 by 1985.

The continuing decentralization of American business, exemplified by today's trend toward smaller, multiplant operations in remote, Sunbelt locations, combined with decreasing airline service to outlying cities have made corporate aviation a necessity. Travel by corporate jet has evolved from a novelty for pioneering entrepreneurs during the initial years of the Model 23 to an essential form of transportation for a broader spectrum of businessmen during the 1980s and beyond.

But with that evolution have come demands for higher reliability, greater comfort and more of the standard accommodations that passengers routinely expect when traveling.

The Gates Learjet Model 55 is a response to the evolving requirements of corporate aviation. The aircraft benefits from the proven systems of the 20- and 30-series Learjets, still the most popular business jets in the corporate fleet, yet it incorporates changes deemed essential by a market that is growing in sophistication.

The most significant of these changes is the Model 55's "standup" cabin, which provides a height of 5.7 feet (with the aid of an aisle that is depressed 5.0 inches), a maximum width of 5.9 feet and a length — 13.9 feet — that is one foot longer than the Model 35's. The larger cabin results in an aircraft that looks very — much like a typical Learjet even though its interior volume is 50 percent greater than that of a Model 35.

In keeping with an emerging trend among builders of corporate aircraft to offer more room and convenience for passengers, Gates engineers chose to use the greater volume of the Model 55 to enhance passenger comfort rather than increase seating capacity. The standard interior arrangement easily accommodates five fully functioning chairs; a two-place, side-facing bench; and an enclosed, aft mounted lavatory.

Baggage can be stowed either within the pressure vessel in a separate location behind the lavatory or in two class D, externally accessible baggage compartments, one in the nose and the other in the aft fuselage.

Ben Isaacman, vice president of interior design for Gates Learjet and a master at the art of optimizing corporate jet interiors for the passenger, paid particular attention to the cabin layout.

Entry Well Planned

The ease of entry into the Model 55 was planned well. The top of the 2.0-foot-wide, vertical clamshell door swings well above head-collision range of even tall passengers, and the three-step airstair in the lower portion drops to within nine inches of the ramp surface. A telescoping or kneeling handrail to jacket the stair retaining cables would have been a nice added touch, but it may not be technically feasible.

For shorter occupants, the 5.7-foot aisle-to-headliner height (1.33 feet higher than the Model 35's) affords true stand-up space, and for taller persons it eliminates the jackknife contortions traditionally associated with smaller aircraft. Club seating, constructed to Gates Learjet's specifications by Custom Products Company of Sun Valley, California, was engineered to overcome the "crabwalk" or side-stepping exercise that is normally required to reach the aft seats. Although the aisle itself is a relatively standard 15-inch width, chair armrests are only 32 inches from the floor, which is below the level at which the human anatomy broadens.

Passenger accommodations in the Learjet 55 demonstrator are very comfortable without being pretentiously plush. The company offers four basic cabin arrangements in a variety of colors and materials. Floor Plan 1A, which is installed in the demonstrator and is expected to be the most popular configuration, is a seven-passenger layout (with aft lavatory) that enhances the impression of spaciousness.

Immediately aft of the partition between the copilot's seat and the cabin is a two-place, 40-inch, side-facing divan with removable arm rests. Beneath it are large storage drawers, and across the aisle is the galley refreshment cabinet. A four-place, club-seating arrangement at mid-cabin includes sturdy, pullout table tops in each sidewall. The seats are fully swiveling, and each tracks 12 inches fore or aft and six inches inboard. Special features include a stowable table leaf that spans the aisle to link the tops of the two pullout tables, thereby creating a cabin-wide work surface. Using the swivel feature of the club seats as well as the interconnecting table top, the four chairs can be arranged in a nearly circular fashion about a "conference" table that spans the width of the cabin.

The cabin seats are fully reclining, moving forward and down (like a home recliner chair) to avoid impinging on the leg room of the adjacent seat. This feature also permits the right forward club seat to join with the divan to make a full-length couch.

The aftmost cabin chair, the seventh, seems to be more confined in space because it is situated immediately ahead of the 33-cubic-foot internal baggage area and across the aisle from an airline-size enclosed lavatory, which is complete with cabinets and wash basin. But a passenger occupying that seat has ample room and light.

From the standpoint of window area, lighting, ventilation and acoustics, there appear to be few if any "hot" or "cold" spots in the Model 55. Opaque and tinted shades for all nine passenger-compartment windows are standard, and the convenience panel above each seat is equipped with double, prefocused reading lights along with very efficient, diffused-stream air outlets.

Separate controls for the environmental conditioning systems, which incorporates two evaporators and a single rotary-type Freon compressor and can be operated at any altitude, serve the cockpit and the cabin. The latter is ducted so effectively that the aftmost seat seems to receive the same inflow as the foremost. Stale air still is exhausted through an outflow valve in the lower portion of the cockpit, but the exhaust system is completely enclosed in the seat pedestal along each side of the cabin except for the outflow openings near each seat.

This exhaust arrangement provided two improvements. First, the temperature of the air flowing beneath the passengers' feet is virtually the same as that of the surrounding air. Thus the floor stays warm. Second, the tobacco effluents from passengers smoking in the cabin are no longer filtered through the lungs of the cockpit crew before being exhausted overboard.

Gates Learjet engineers are justifiably proud of the inflight sound levels of the Model 55. In fact, they refer to them as "quietness levels." That description is quite appropriate because a measurable part of the 1,000- to 1,200-pound weight of interior outfitting is made up of sound-deadening lead-vinyl blanketing.

B/CA measured noise levels in the passenger cabin at both high-altitude cruise and maximum Mach numbers, and in low-level, partial-power operations in the landing pattern. In the former, with the environmental system in its configuration with the air vents open, readings of 80 to 83 decibels were recorded, the highest being near the aft-cabin baggage door. In the latter, at about 5,000 feet, 61.5 percent power, 190 knots IAS and cabin fans turned off, readings varied from 75 decibels in the cockpit to 73 decibels midcabin and 77 decibels at the seal of the aft baggage door. We concluded, therefore, that the increased amount of circulating air offered in the Model 55 contributes to elevated sound levels, but our overall impression is that the Model 55 pleasantly lacks fatigue-inducing noise; it's among the quietest business jet interiors we've ever encountered.

With regard to interior outfitting, Gates Learjet craftsmen perform work of the highest quality, if the demonstrator aircraft can be used as an example. Concern for weight saving may have some impact on the ruggedness of trim materials used, however. In the demonstrator aircraft the plastic convenience panel had begun to loosen and curl on the right side of the forward cabin.

Reliable Systems

While the fuselage represents a significant departure from the traditional Gates approach to cabin size, the majority of the Model 55's systems are typical Learjet. The company's objective was to achieve the highest possible reliability by using as many proven components as possible from the 20- and 30-series Learjets and incorporating new systems or system changes only where they provided a definite advantage. Consequently, the Model 55 (with the exception of its fuselage) was conceived and implemented as a derivative aircraft, and its type certificate is based upon the original Learjet's TC, amended to include applicable FAR Part 25 changes through 1977. Areas that came under scrutiny by the FAA during its recent special certification review, such as the Learjet's automatic flight control and pitch trim systems, were improved or changed while particularly popular Learjet features, such as jet pumps and Freon air conditioning, were retained.

The Model 55's fuel system consists of internal wing tanks (1,424 pounds in each wing) and a bladder-type fuselage tank (about 3,850 pounds). Two electrical fuel pumps (DC) are used for starting and as standbys for emergencies, but the primary sources of fuel pressure are jet pumps, which were proven to be exceptionally reliable in earlier Learjets. An engine-driven fuel pump on each engine can provide sufficient fuel flow for normal operation below 25,000 feet,. should the electrically operated pumps and jet pumps fail.

Gates Learjet deviated from the fuel system of its earlier models by offering fuel heaters and single-point refueling; thus far nearly 90 percent of the Model 55s ordered have included those options.

Like the fuel system, the hydraulic system of the Model 55 is similar to that of other Learjets. The gear, however, has a free-fall capability new to Learjets, and the antiskid system is continuously self-monitoring, thereby needing no test switches. Also, the nosewheel's power steering functions through an are of 55 degrees, compared with the Model 35's steering range of 45 degrees.

The Model 55's electrical system is nearly identical to the ones in later 20- and 30-series Learjets, except that dual, lead-acid, metal-encased batteries are standard, with ni-cads being optional. Each engine is equipped with a 400-amp brushless DC generator, and either generator can power the electrical system, including either of the Model 55's 1,000 volt-amp, frequency-regulated inverters. Gates Learjet uses separate starters and generators, rather than starter-generators, to increase reliability.

The standby attitude gyro and N1 indicators, as well as the gear and flap indicators, can be powered by a single emergency battery, which is part of the standard equipment list. A second emergency battery is optional, and it can be wired to serve a number of additional items, such as communication equipment.

Unlike the 30-series Learjets, which use bleed air, the Model 55 has electrical heating elements to anti-ice the horizontal tail. Alcohol was eliminated from the unnecessary, and no bleed air was deemed necessary to keep the engine's conical fan-hubs clear. Otherwise, icing protection for the Model 55 is similar to the 30-series: bleed air to heat the wing leading edges, nacelles and windshield; alcohol for' the windshield; and electrical heaters for the pitot-static system and stall vanes.

A measure of that similarity was achieved when the Model 55 was approved for flight in known icing at the time of its original certification.

Evolutionary Development

The Model 55 is powered by two Garrett AiReasearch TFE 731-3A-2B turbofan engines, which each develop 3,700 pounds of sea level thrust at takeoff while achieving noise levels below those required by Part 36. The -2B designation denotes that the engine is configured for a Learjet and the -3A identifier signifies that this model engine uses special fan blades (for better performance at altitude) and a small hub at the fan section. Since the -3A's hub is smaller and its fan blades are longer than those of early Model 731s, more air flows through the core than on the 30-series TFE 731-2-2B engines, which develop 3,500 pounds thrust.

Also, the Model 55's engines are located higher on the fuselage, creating less of a flow restriction for the air that passes between the wing-fuselage juncture and the engine nacelle. The, result is less interference drag from air being choked by the channel effect associated with the proximity of the nacelle and wing on the 20and 30-series Learjets.

Like the Model 55's systems, the aircraft's aerodynamic configuration evolved from earlier Learjets. Its Longhorn wing was developed and certificated on the Model 28 Learjet in anticipation of using the design for the Model 55 ("Gates Designs the 'Ideal' Learjet," B/CA, September 1979, page 45). Except for the use of higher-strength aluminum, the structural design of the Model 55's Longhorn wing is identical to the Model 28's and 29's.

Since the time when the Model 28 and 29 were certificated, however, Gates Learjet has incorporated two wing fences, a stall strip and boundary layer energizers (BLEs) on each wing to improve the aircraft's low-speed and stall characteristics. All Learjets, whether fitted with the Longhorn wing or the wings of either the 20- or 30-series, now are equipped with these "Softflite" features, although only the Longhorn wing (due to its extra length) has two fences per side.

The vertical tail of the Model 55 is about 20 percent higher than that of 20- and 30-series Learjets, thereby enhancing the aircraft's directional stability. The Model 55 also benefits from an improved yaw damper system consisting of two completely separate servos that can be operated during taxiing, takeoff and landing. The system has two levels of authority: a low level for ground and flaps-down operation and a higher level for flight segments when the flaps are

retracted. The result is good yaw damping throughout the flight envelope, including takeoff and landing.

Unlike the 20- and 30-series Learjet, the Model 55 has a two-speed, primary longitudinal-trim motor in addition to the secondary trim motor that is standard on all Learjets. From the neutral index to the full-down trim position, the primary longitudinal-trim motor runs one-fourth its normal speed.

Other control changes that the Model 55 enjoys are large pulleys in the crew's control system for better gearing and an improved feel, The aircraft also incorporates a preselect feature for setting the desired flap deflection.

One of the most significant changes in the flight control system is the use of Jet Electronics Technology Incorporated's new JET 550 autopilot. In addition to being designed for increased reliability, the unit offers a half-standard-rate turn capability and altitude preselect. The JET 550 captures altitude very smoothly and precisely, even with high rates of Closure, because its capture logic is based upon rate of climb, not just preselected altitude.

Another change that pilots will appreciate is the use of a Rosemount pitot-static system.

Position error is nil on the Model 55, and no longer do the altimeter and rate-of-climb indicator give an initial reading that is backwards when the aircraft is maneuvered briskly at altitude.

Handling and Performance

Despite its size and 20,500-pound gross weight, the Model 55 flies like the smaller Learjets. Takeoff acceleration is characteristically quick, particularly at the 17,315-pound weight we had for our evaluation flight. Pitch response at liftoff is prompt and well damped, allowing a pilot to capture the recommended nine-degree attitude for an initial climb without a tendency to overshoot. Speed stability, as well as cockpit visibility, is very good in all configurations.

We were impressed by how well the yaw damper functioned during the flight. Its dual mode suppressed any pronounced tendency for Dutch roll after takeoff and during the approach and flare; in climb, cruise or descent the Model 55 exhibited very solid lateral/directional stability.

The aircraft behaves well at altitude in high-speed cruise. If the high-speed boundaries are approached (for example, by inducing g-forces in a steep turn), the aircraft experiences a typical buffet, but there is no tendency to roll or pitch violently. In fact, the aircraft maintains its composure and is fully controllable. As the aircraft reaches its Mmo in level flight, a high-frequency aerodynamic buffet is apparent, almost as a natural warning that the Mach limit has been reached. The source of this buffet is a small region of flow separation at the juncture of the winglet and the wingtip. No aileron buzz or control deterioration accompanies that phenomena, however. (Mmo is 0.81 Mach up to 37,000 feet, decreasing to 0.79 Mach at 45,000 feet and remaining at that figure to 51,000 feet.)

Fully developed stalls with the big Learjet are rarely experienced due to the Model 55's stall warning and protection system, which retains the alpha dot (rate of change in angle of attack) feature of late 20- and 30-series Learjets but adds an extra function that nudges the control stick forward at the onset of the stick shaker and prior to the onset of the stick pusher's full authority. The nudger mode works in conjunction with the pusher's servo; thus it serves as an indication that the stick pusher is functioning properly. Using that warning and protection system, the aircraft retains full aerodynamic control at its minimum flying speed, with no untoward gyrations resulting from exciting the stick pusher. An aerodynamic buffet due to flow separation near the wing-fuselage juncture also provides a natural warning of the aircraft's low speed boundary.

During our flight we matched Gates Learjet's book performance. For our weight, which was predicated mainly on departing close to the aircraft's maximum landing weight of 17,000 pounds,

we reached FL 410 17.5 minutes after departing Tucson International Airport (elevation 2,630 feet, OAT 25°C, and we had no difficulty operating at FL 470.

From our performance analysis, it appears that the 51,000-foot capability will be used only when the Model 55 is flown at significantly reduced weights.

Flight Level 410 is practical as an initial climb altitude after a full-gross takeoff, and FL 450 is a practical level for routine operations after some fuel is consumed. Based upon the results of the recent Wichita-to-Paris flight piloted by Bib Stillwell, general manager of Gates Learjet's Aircraft Division, the optimum long-range cruise Mach number appears to be 0.72, not 0.70 as specified in the Model 55's AFM.

At its maximum gross weight, the Model 55's runway requirements tend to be long, particularly from hot and high airfields. Part of the reason for that is the aircraft's higher than anticipated stalling speeds, which reflect a 5.5- to 6.0-knot margin in certificated stall speed over what the Model 55 is capable of achieving aerodynamically. Every knot of extra speed at the stall adds about 100 feet to the balanced field length. Gates Learjet engineers are working to reduce the certificated stall speed in order to recapture better airport performance.

The Model 55 retains the performance, feel and style of the smaller Learjets while offering the first "standup" cabin in Gates Learjet's product line.

As such, the aircraft opens up new markets for a company that traditionally has had difficulty attracting operators who insisted upon medium-size or larger jets. It also offers existing Learjet operators an opportunity to expand their capabilities without moving to a different manufacturer's aircraft.

The company that has its roots in the creation of corporate jets and has stayed with the formula of small cabins, but high performance is entering a new era of aviation with the addition of its medium-size Model 55. B/CA