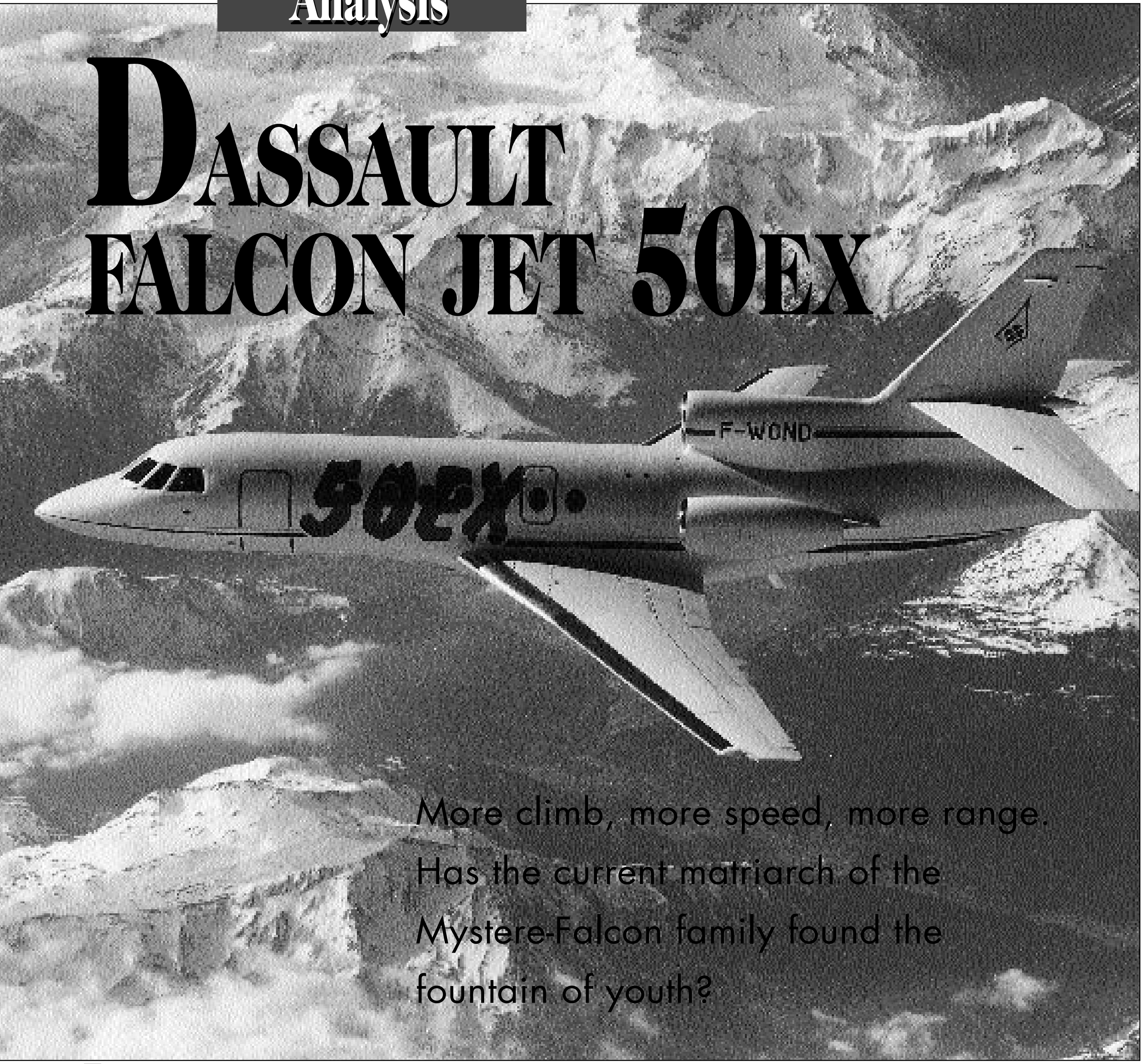
Analysis

DASSAULT FALCON JET 50EX



More climb, more speed, more range. Has the current matriarch of the Mystere-Falcon family found the fountain of youth?

Photography courtesy of Dassault Falcon Jet

There are more than 1,200 mineral springs in France, many of which have been used for medicinal purposes since prior to the arrival of the Romans. Some local folks claim "les bains" can even roll back the clock on the effects of aging. Glance at the performance improvements of Dassault's Falcon Jet 50EX and you might believe that Dassault discovered the true fountainhead among those springs.

There's nothing so mystical, though, brewing in the firm's engineering department. The actual rejuvenation formula is a classic two-part blend. Start with Dassault's pioneering use of computers to model fluid dynamics that began in the mid 1970s. That resulted in the original Falcon 50's having less drag than even some of its smaller competitors. Then add in highly evolved, second-generation AlliedSignal TFE731-40 turbofans that offer more takeoff thrust flat-rating, more high-altitude cruise thrust and better specific fuel consumption than the original AlliedSignal (née Garrett-AiResearch) -3 engines.

The result is the rebirth. The old Falcon 50 first delivered in 1979 is gone. The 50EX, certificated by the FAA and DGAC in late 1996, emerges from its chrysalis, complete with paint and interior, for the first customers in the second quarter of this year.

Compared to its predecessor, the EX

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offers substantially improved climb and cruise performance, and it can squeeze more nautical miles out of each pound of fuel. As a result, the EX can fly eight passengers 3,000-plus nm at 0.80 IMN and land with NBAA/IFR reserves. That's a 400-nm range increase compared to the original Falcon 50 flown at the same speed with no increase in fuel capacity.

At 0.75 IMN, the EX can squeeze 3,265 nm of range out of the same fuel load, a 200-nm advantage over its predecessor. While the extra range at 0.75 IMN may be needed on a few trips, most operators probably will fly 0.80 IMN because of the relatively small range penalty.

To ensure that the flightcrew can take full advantage of the additional climb, speed and range performance, Dassault has upgraded the avionics to a Collins Pro Line 4 package, which is almost identical to the one in the Falcon 2000.

Passengers, though, are more likely to appreciate the cabin comfort before the engine and avionics upgrades. The EX has lost nothing of the roominess that Dassault designed into the Falcon 50 almost two decades ago. The cabin has the largest cross section of any current production mid-size business jet. The length of the usable cabin also is one of the longest in its class. The interior literally stretches the definition of a mid-size business aircraft. The EX's furnishings are topnotch, reflecting the evolution of Dassault's Little Rock completion center into a world-class facility.

Operators will appreciate the 50EX's operating flexibility. Similar to the Falcon 50, the EX has virtually no range/payload tradeoffs, even when departing most high-density-altitude airports. You can fill the tanks, fill the seats, stuff another 680 pounds into the baggage compartment and then depart at MTOW. After takeoff, the Falcon 50EX can fly its maximum allowable payload with full fuel farther than any competitor in its class.

STRUCTURE AND SYSTEMS

Falcon Jets primarily are conventional aluminum monocoque structures. Composites are used for secondary structures such as ailerons, landing gear doors, fillets and the radome. The 50EX's fuselage is reinforced with many closely spaced slim frames and stringers, which maximizes the interior cross section. The center fuselage section has an integral wing box carry-through structure to which each wing bolts, similar to other current production Falcon Jets.

The EX uses most of the original Falcon 50 systems. Pilots will find familiar systems diagrams and color-keyed circuit breakers on the overhead panel. The biggest changes in the cockpit are in avionics. (See sidebar.)

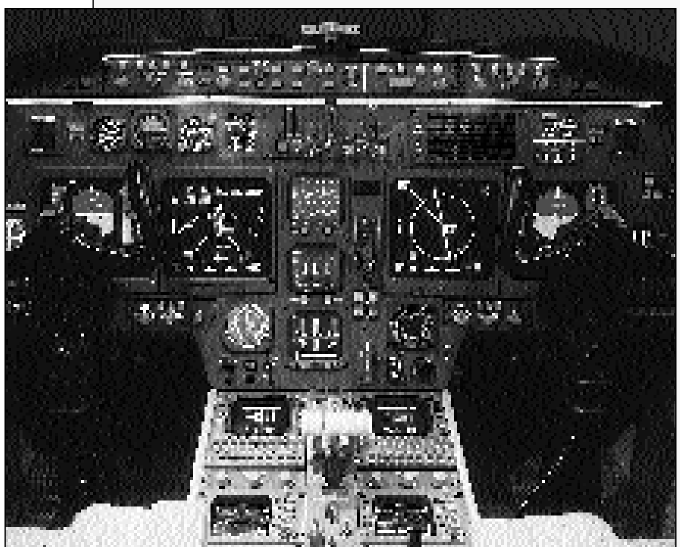
The fuel system has three wing tanks and three engine-feeder tanks mounted aft of the cabin in the fuselage. Electrical transfer pumps in the wing tanks, augmented by bleed air pressurization, move fuel to the feeder tanks which hold about one-third of the total fuel capacity. A second set of electrical boost pumps moves fuel from the fuselage tanks to the engines.

Each engine, along with the APU, has a starter-generator that supplies 28 VDC electrical power to two main electrical buses. Static inverters supply AC power to certain systems, such as optional office equipment in the cabin and a 117 VAC outlet in the lavatory. The APU is certificated for ground use only.

There are two main hydraulic systems. One system is powered by pumps on two engines. The second system is powered by one engine-driven and one electrically driven pump. Hydraulic power is used to actuate the flight controls, artificial control feel system, landing gear and wheel brakes, slats and flaps, nosewheel steering, spoilers and the thrust reverser on the center engine.

The flight controls are fully powered by both hydraulic systems, not unlike a Mirage or Super Étendard. If both hydraulic systems fail, the flight controls can be manually actuated.

FALCON 50EX AVIONICS



The 50EX's panel and console are radically different from those of the Falcon 50, but they only hint of the changes made to the avionics package. A Collins Pro Line 4 integrated avionics package, featuring four 7.25-inch EFIS tubes, forms the heart of the new system. Dual Collins comm radios, nav receivers, DME units, mode S transponders, ADF receivers, digital air data computers and a dual-channel APS 4000 autopilot are included, along with a single data acquisition unit (principally for engine data), a TWR 850 Doppler turbulence detection weather radar and a radio altimeter.

The package also includes dual Honeywell Laseref III inertial reference systems, dual AlliedSignal GNS-X FMS (Universal UNS-1C FMSes are optional), a Teledyne Controls MagnaStar or AlliedSignal Flitefone 800 radiotelephone, a CVR, an ELT, dual AlliedSignal HF transceivers with SELCAL and an AlliedSignal GPWS.

The upgraded standard avionics package, along with the standard APU, heavier engines and other equipment, are prime reasons why the EX has gained 980 pounds in BOW.

Dassault and Collins also plan to offer the 50EX's Pro Line 4 avionics for retrofit into earlier Falcon 50 aircraft.

An oven, coffee maker, ice chest and storage container are standard, and Dassault offers a variety of galley options.

The aft cabin has a three-place, side-facing divan and two facing chairs that adjust for swivel, and fore and aft track.

Notably, Dassault increased the 50EX's rudder travel by seven degrees to enhance the yaw control authority at low speeds.

"Arthur Q" units provide the roll and pitch controls with variable-load artificial feel in proportion to indicated airspeed and horizontal stab position. The result is a nearly constant stick force per g of vertical acceleration, much the same as a far smaller aircraft with manual controls.

The primary flight control surfaces don't have trim tabs. Electric artificial-feel unit actuators in the aileron and rudder linkages provide trim control. Pitch trim is provided by a moving horizontal stabilizer.

Two air-cycle machines using engine or APU bleed air provide air conditioning in a dual zone (cockpit and cabin) temperature control system. The crew controls pressurization with a conventional controller that has baro set, rate and altitude knobs.

The baggage compartment aft of the fuselage feeder tanks also is pressurized and the forward equipment bay in the nose cone is partially pressurized to control temperature and humidity.

Engine bleed air also is used for wing leading edge, center engine S-duct and engine nacelle anti-ice. Electrical heating protects the glass windshields, pitot-static and angle-of-attack probes, and engine-inlet pressure and temperature probes. Windshield wipers provide rain removal.

The Falcon 50EX, similar to the 900EX, gets a new bleed-air supply computer that automatically regulates high- and low-pressure bleeds from the engines. The BASC reduces pilot workload and increases fuel economy by precisely metering bleed air for pressurization and anti-ice functions.

Another system change is the addition of a digital engine-data acquisition system for use with the Sextant engine indicator electronic displays. The EIEDs also are linked with engine vibration monitors that have been fitted to the 50EX.

CABIN AMENITIES

Passengers enter the 50EX by means of a 31.0-by-59.8-inch airstair door that has a pneumatic assist to ease closing. There are two Type III emergency exit doors on the left and right sides of the aft cabin.

Forward of the main door, there are two spacious closets ahead of a flight deck curtain. There is a third, 15-inch-wide coat closet just aft of the curtain, on the right side that adjoins the 33-inch-wide galley. An oven, coffee maker, ice chests and storage containers are standard equipment, and Dassault Falcon Jet offers a wide variety of galley options.

The main cabin is configured in two sections with seating for nine people. In front, there is a four-seat club section with executive work tables between facing chairs. The aft cabin has a three-place, side-facing divan on the right side and two facing chairs on the left. Each facing chair has adjustments for swivel, fore and aft track, and sideways movement, and is fully berthable.

A full-width lavatory, equipped with an externally serviced, flushing toilet, is located aft of the seating area. A central water system, which can be filled internally or externally, supplies both the lavatory and galley.

The pressurized, aft baggage compartment is not accessible in flight. A 39.0-by-28.9-inch external door, with steps, provides access.

The baggage compartment has 90 cubic feet of volume and a 2,205-pound weight limit.

FLYING THE 50EX

It's indeed rare when we get to fly an airplane for more than an hour or two for an "Analysis." In the case of the 50EX, though, we logged 11 hours in the left seat.

Our mission was to fly s/n 255 in "green configuration" between Bordeaux and Little Rock via Halifax, Nova Scotia on January 23. That's a no-wind distance of 4,803 nm.

"Green configuration" is a relative term. Dassault installs the complete avionics package, certificated for MNPS airspace navigation and soon to be certificated for RVSM altimetry precision, at Bordeaux. Most of the wiring harnesses, cabin insulation and composite headliner panels also are installed in France. We flew in shirt-sleeves warmth and comfort. In contrast, early Falcon Jets were ferried to the United States with portable VLF-Omega systems, the most basic instrumentation and bare metal skins that were chilled as cold as -56°C by the slipstream.

Dassault flight-test pilot and engineer Etienne Faurdessus did all the heavy work. He planned the two legs, prepared s/n 255 for the journey, checked onboard equipment, operated the radios, kept the trip logs and guided us through every step.

Douglas Andrews, chief pilot at Dassault Falcon Jet's completion facility, accompanied us as safety pilot and John House, DFJ's director of commu-

The weather was perfect for a B/CA flight evaluation: rain, clouds and turbulence.

Our BOW with two passengers, ferry kit and survival gear was 21,320 pounds.

nications, rode along to answer technical questions.

The weather was perfect for a flight evaluation: rain, clouds and intermittent turbulence in Bordeaux, Halifax and Little Rock. Our BOW with two passengers, ferry kit and survival gear was 21,320 pounds. This is almost 1,000 pounds more than last year's Falcon 50, but it includes many standard items that previously were options, including an AlliedSignal 36-150 APU.

Full fuel on the slightly cooler than standard day was 15,600 pounds, resulting in a ramp weight of 36,920 pounds.

Faurdessus started the APU shortly before 1:00 p.m. local time (1200Z) and copied the clearance to Halifax. At 1208Z, we started the engines. The -40s' single-channel digital electronic engine controls monitor all start parameters, much the same as FADECs, and they will terminate the start in the event of an abnormality.

After the normal systems and flight control checks, we secured the APU and taxied for takeoff. The hand-wheel controlled, hydraulically powered nosewheel steering has excellent feet and provides +/-60 degrees of steering authority. Nosewheel steering is not available through the rudder pedals.

En route to the runway, we checked the number-two-engine thrust reverser and anti-ice systems. Configured for a slats-plus-flaps-20-degrees takeoff at 36,800 pounds, we set the speed bugs on the PFDs at 108 KIAS for the V_1 takeoff decision speed and 120 KIAS for the rotation and V_2 takeoff safety speeds. Our published takeoff field distance was 4,200 feet and the computed N_1 speeds were 87.6 percent for the number one and three outside engines, and 88.5 percent for the number two center engine. S-duct and thrust reverser losses require slightly higher takeoff N_1 to obtain the desired thrust.

Once cleared for takeoff at 1214Z, we moved the thrust levers up to the forward stops. The DEECs handle the thrust setting chores, as indicated by the N_1 rpm matching the tick marks on the EIED. Initial acceleration was moderate, no doubt a reflection of the EX's comparatively modest takeoff thrust-to-weight ratio.

The pitch force at rotation was pleasantly light, as was roll control force. As we've noted about other Falcon Jets, the control forces seemingly shrink the airplane in size without being overly sensitive in feel.

Air Traffic Control stopped us a few times en route to our initial cruising altitude of FL 390, including a rather

ALLIEDSIGNAL TFE731-40 TURBOFANS

Both the Falcon 50 and the 50EX have TFE731 engines rated at 3,700 pounds of thrust for takeoff on a standard day, but that's where the similarity ends. Thermodynamically, the -40 is a 4,700-pound-thrust engine that is an offshoot of the -5B development program. It has a much more robust core with a one-third higher pressure ratio, made possible in large part by a new centrifugal flow, high-pressure compressor and single-crystal high-pressure turbine blades.

What a difference higher compression makes. The -40 maintains its sea-level takeoff thrust to 32°C (90°F) versus 25°C (77°F) for the -3. At B/CA's 5,000 feet, ISA+20°C benchmark, the -40 can produce more than 93 percent of its sea-level thrust, but the -3 falls off to less than 82 percent.

At cruise altitude, the -40 produces up to 24 percent more thrust and it squeezes up to seven percent more thrust energy out of each pound of fuel.

Pilots will appreciate the digital electronic engine control. The DEEC is a single-channel system, with a hydromechanical backup, that provides most of the benefits of a FADEC, but at lower development cost. It incorporates automatic start and restart functions, N_1 engine sync, plus/minus five-percent authority autothrottles for maintaining cruise Mach and automatic max-thrust limiting, and it will log malfunctions.

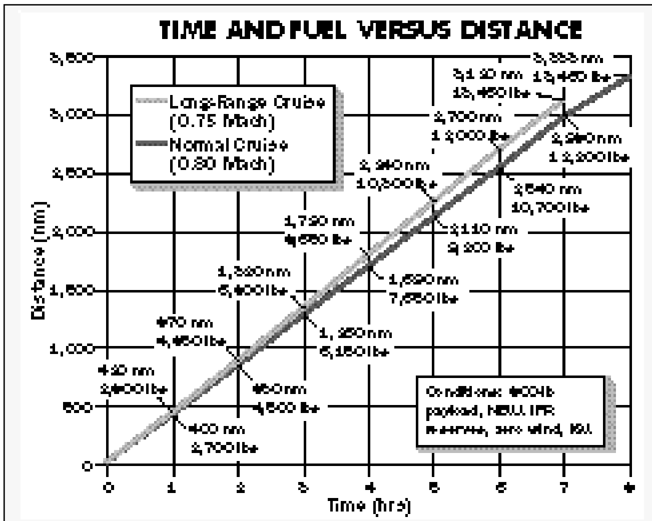
Maintenance intervals have been increased to 2,500 hours for major periodic inspections and 5,000 hours for compressor zone inspections. In contrast, the -3 has a 1,400-hour MPI and 4,200-hour CZI. AlliedSignal's basic Maintenance Service Plan rate for the -40 is $104.82 per hour (North America) compared with $118.71 per hour for the -3 engine.

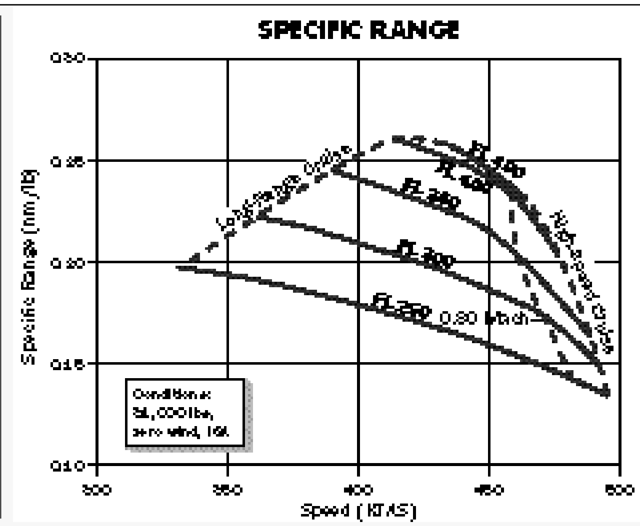
The downside? The -40 weighs about 80 pounds more than the -3 turbo. Dassault reduced some of the net weight gain by reducing avionics wire weight and by improved manufacturing technique.

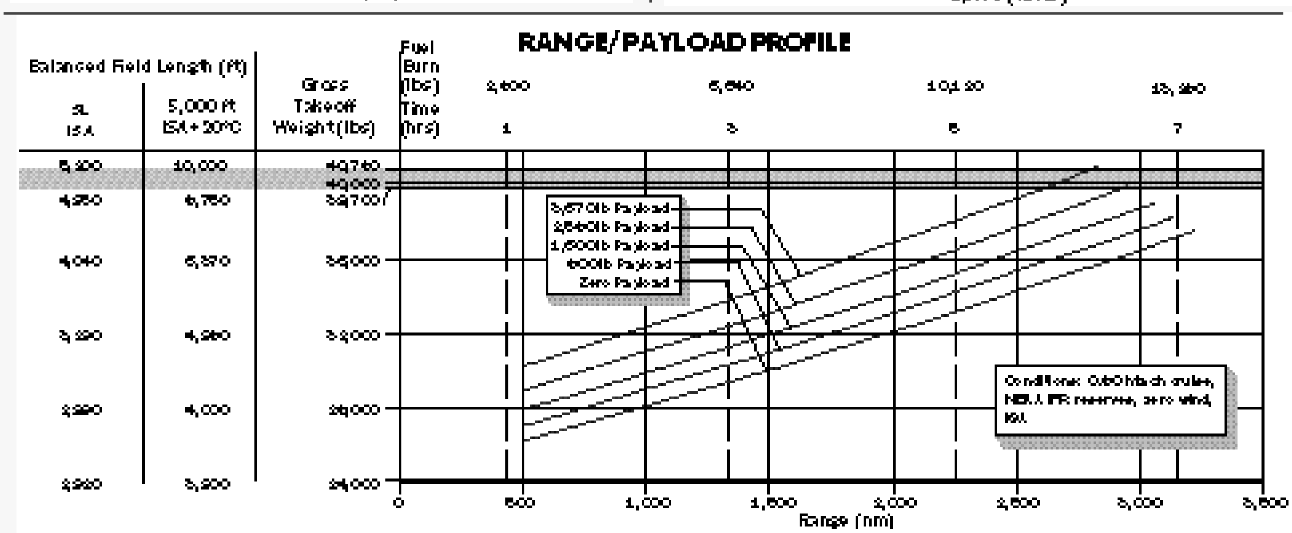
long delay at FL 350 during which we accelerated to 0.80 IMN. We finally leveled at FL 390 in ISA+5°C conditions, 35 minutes after takeoff, the EX having consumed 2,120 pounds of fuel. Our fuel flow stabilized at 2,030 pph, resulting in a 0.224 nm/lb specific range at 0.80 IMN or 455 KTAS.

Ducting or thrust reverser loss on the center engine were quite apparent at altitude. If we manually matched the N1 speeds of all three engines, the center engine consistently burned 40- to 50-pph less fuel. If we matched the fuel flows, the center engine N1 was 3.5- to 4.0-percent higher than the outboard engines.

By the time the first EX reaches its operator, cruise thrust setting chores will be automated. The DEECs have a five-percent N1 adjustment range.







Data source: Dassault Falcon Jet

DASSAULT FALCON JET 50EX

These three graphs are designed to be used together to provide a broad view of Dassault Falcon Jet 50EX performance. Do not use these data for flight planning. For a complete operational performance analysis, consult the Falcon 50EX airplane flight manual and appropriate cruise performance data supplied by Dassault Falcon Jet.

Time and Fuel Versus Distance—This graph shows the performance of the Falcon 50EX at 0.75 IMN long-range cruise and 0.80 IMN normal cruise. The numbers at the hour lines indicate cumulative miles and fuel burned for each of the two cruise profiles. The narrow spread between the long-range and normal cruise line endpoints suggests that these speeds are close to the aerodynamic cruise design point of the aircraft. The intermediate points are approximated from climb, cruise and descent data contained in Dassault's proprietary Falcon 50EX flight-planning software. Our 11 hours flying the 50EX, however, indicates that Dassault's published cruise performance numbers are accurate.

Specific Range—The specific range of the Falcon 50EX, the ratio of nautical miles flown to pounds of fuel burned (nm/lb), is a measure of its fuel efficiency. This graph shows long-range cruise, 0.80 IMN cruise and high-speed cruise specific range values throughout the typical cruise altitude envelope of the Falcon 50EX at 31,000 pounds. The chart shows that there is little value in climbing above FL 410 except to escape strong headwinds. However, the relatively narrow spread between maximum range and 0.80 IMN cruise specific-range values at the top of the envelope indicates that speed and fuel economy are optimized when cruising at or above FL 410.

Range/Payload Profile—The purpose of this graph is to provide rough simulations of trips under a variety of payload and airport density-altitude conditions, with the goal of flying the longest distance at 0.80 IMN normal cruise. The payload lines, which are intended for gross simulation purposes only, are valid only for the end-

During the descent through multiple layers of rain-soaked clouds, we had ample opportunity to exercise the Collins TWR-850 Doppler turbulence detection weather radar.

This feature will be used to set N1 in cruise to hold an indicated Mach number and also for engine speed sync. These two functions weren't yet operable in s/n 255 during the ferry flight.

Three hours, 12 minutes into the flight over the mid Atlantic, we climbed to FL 430 slightly ahead of schedule in an attempt to avoid increasing headwinds. The EX was 680 pounds over Dassault's recommended weight for the step climb, as showed by our 200- to 300-fpm final rate of climb. Once level, though, the aircraft accelerated to 0.792 IMN. The total fuel flow was 1,820 pph at 456 KTAS, resulting in a specific range of 0.251 nm/lb—slightly better than forecast by Dassault's engineers. Near the top of descent, the total fuel flow had dropped to 1,630 pph, resulting in a 0.277 nm/lb specific range at 0.80 IMN.

The headwinds at FL 430 increased from 39 to 91 knots during the next three hours as we neared Nova Scotia; therefore, we had no problem accepting an early descent from Moncton Center as it helped us get out of the wind.

During the descent through multiple layers of rain-soaked clouds, we had ample opportunity to exercise the Collins TWR-850 Doppler turbulence detection weather radar. The radar detected only moderate rain and no hazardous turbulence, indications we soon verified as we descended through light to moderate chop with plenty of icing and rain showers.

We broke out of the clouds at 4,500 feet about 20 miles east of Halifax and proceeded to align with Runway 24. The runway was wet and there was a 15- to 20-knot direct crosswind out of the northwest. In some airplanes, this could prove challenging. In the case of the 50EX, it just brought out its fine breeding.

Two miles out, we slowed to the 103-KIAS V_{REF} landing approach speed with slats and flaps 48 degrees, and stabilized in a healthy right crab. Nearing the threshold, we transitioned to a conventional wing down/top rudder slip to align the nose with the centerline, reduced thrust to idle and flared to touch down on the upwind main landing gear. The EX flattered us with a gentle touchdown, in spite of its straight-leg oleos. After that, we settled onto both mains and Faurdessus extended the ground spoilers. We also used the center thrust reverser to help slow the aircraft, and exited the runway about 4,000 feet after touchdown.

FALCON 50EX OPERATING COSTS

Fixed Expense (Annual):	
Crew + Benefits	$137,878
Hangar	83,352
Insurance—Hull (0.25%)	40,125
Insurance—Admitted Liability	2,750
Insurance—Liability	14,000
Recurrent Training	23,500
Navigation Charts	2,338
Updates/Uninsured Damage	64,200
Refurbishing	35,280
Computerized Maintenance	7,242
Weather Services	2,000
Depreciation	0,000*
Total Fixed Expense	$412,665
Direct Expense (Hourly):	
Fuel	$549.44
Maintenance—Labor	120.40
Maintenance—Parts	113.05
MSP @$104.82 per engine	314.46**
Thrust Reverser	0.00
APU Reserves	23.94
Landing/Parking	11.91
Crew Expense	135.00
Catering/Supplies	36.85
Total Direct Expense	$1,305.05

*Tax depreciation omitted.
**AlliedSignal Maintenance Service Plan

Source: Conklin & de Decker Associates, Inc., Orleans, Mass. (except as noted by asterisks).

Our actual fuel burn for the seven hour, six minute flight was 13,240 pounds. Prior to departure, Faurdessus computed a total fuel burn of 13,300 pounds. The equivalent still-air distance for the trip was more than 3,060 miles, and we had arrived with an NBAA IFR reserve of 2,500 pounds.

Halifax was experiencing a veritable heat wave on January 23. The temperature was a balmy 43°F, allowing us to walk to the FBO in shirtsleeves. The occasional rain showers were melting the snow drifts.

After refueling, we taxied to Runway 33 for an upwind takeoff at a takeoff weight of 32,380 pounds. On the roll, just after V1, Faurdessus pulled the number-one-engine thrust lever to idle, simulating an engine failure. The three-engine configuration and fully powered rudder resulted in a modest reduction in climb rate and easy handling characteristics. If we actually had experienced an engine failure, we could have immediately returned for landing at Halifax because the aircraft was well below its 35,715-pound max landing weight.

We climbed directly to FL 430 and set maximum cruise thrust. The aircraft accelerated to 0.804 IMN at a weight of 30,870 pounds in ISA conditions. Three hours into the trip in ISA-5°C conditions, the aircraft had accelerated to 0.856 IMN, resulting in a true airspeed of 475 knots.

The weather in Little Rock was smooth, but there were cloud layers from 1,000 feet agl to 10,000 feet msl. Approach control issued plenty of vectors, altitude and speed changes to a half dozen or so aircraft landing at Adams Field.

This environment brought out other characteristics of the 50EX. The new Pro Line 4 package is generally well organized, but there are a few ergonomic shortcomings. While the 7.25-inch displays are first rate, some of the display controls are located on the console and some on the "eyebrow" or glareshield control panel. This results in two-step hand-eye coordination. First look for the appropriate control knob, switch or button and move your hand to it. Second, look at the display to view the desired result of actuating the control.

For example, the speed-set knob used to move the "bugs" on the airspeed scale is located next to the baroset knob on a panel in the console. It's easy to twist the wrong knob without first looking down at the console to

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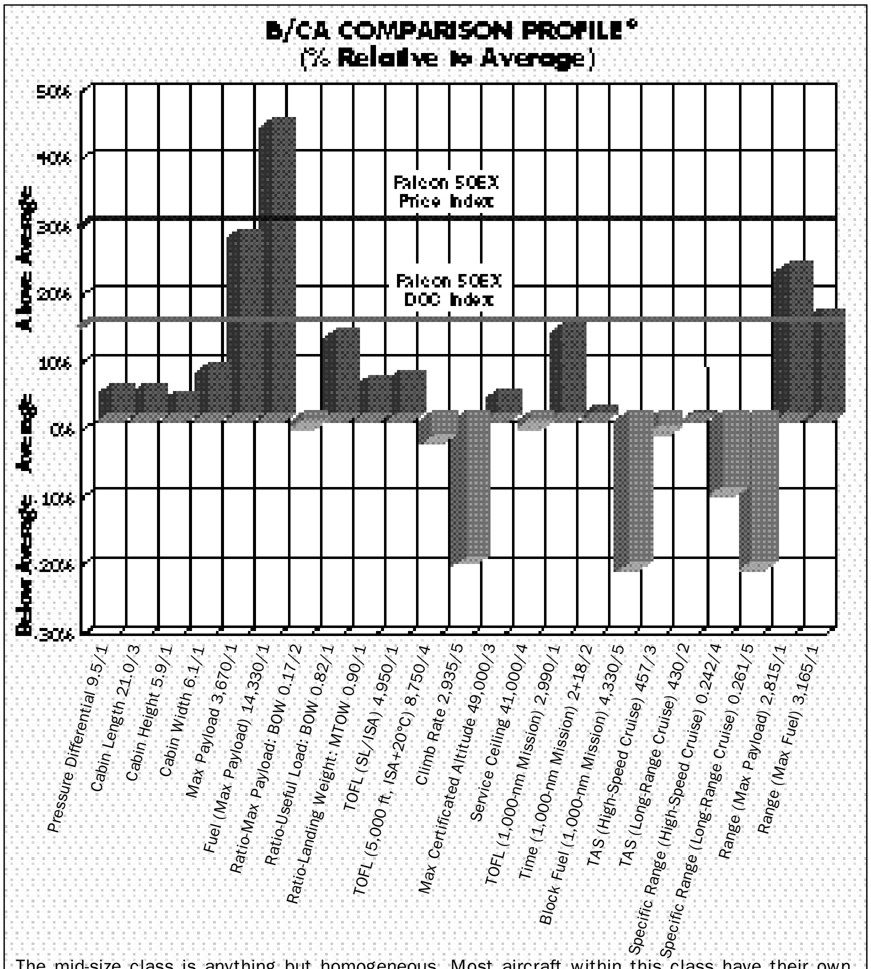

The mid-size class is anything but homogeneous. Most aircraft within this class have their own niche. No one aircraft can do all missions with speed, efficiency or passenger comfort equal to the group average. Each model demonstrates that tradeoffs are a reality of aircraft design.

B/CA compares the subject aircraft's performance and characteristics to the composite traits of the aircraft in its class. We do this to evaluate the strengths and compromises of the subject aircraft. We average parameters of interest for the aircraft that are likely to be considered as competitive with the subject of our analysis, and then compute the percent differences between the parameters of the subject aircraft and the composite numbers of the competitive group as a whole. The percent differences are presented in bar-graph form. We also include the absolute value of the parameter under consideration, along with its rank with respect to the composite.

For this and subsequent reports, we've added a Direct Operating Cost (DOC) reference line, along with the usual price index line. The DOC data were furnished by Conklin & de Decker Associates, Inc. of Orleans, Mass.

For this Comparison Profile®, we present select parameters of the Falcon 50EX in relation to a composite group consisting of the Astra SPX, Learjet 60, Hawker 800XP and Citation X. The Comparison Profile® is meant to illustrate the relative strengths and compromises of the subject aircraft; it is not a means of comparing specific aircraft to each other.

locate the correct knob. In our opinion, pilots transitioning to the EX will need plenty of time practicing such hand-eye coordination in a cockpit procedures trainer prior to their first flights.

Nearing the airport, at the request of air traffic control, we slowed to our 102 KIAS V_{REF} approach speed to accommodate a Piper Seneca ahead of us on the ILS approach to Runway 4R. Once below the clouds, we sidestepped to Runway 4L to avoid a long inbound taxi to Dassault Falcon Jet's completion center on the north side of the field.We touched down without finesse and firmly applied the brakes to make the first exit off the runway. Our total fuel burn for the 1,833-nm second leg was 6,940 pounds.

PERFORMANCE VERSUS PRICE

The Comparison Profile® illustrates that the Dassault Falcon Jet 50EX occupies a niche of its own at the top of the mid-size class. It has few direct competitors because of its range, speed and payload capacity.

Its performance and payload, along with its purchase price and direct operating cost, almost push it up into the heavy-iron class. For example, its fuel consumption is closer to some highly fuel efficient large-cabin aircraft than the composite average of the mid-size class.

The basic price of admission to the large-cabin class, however, rapidly is escalating to $20 million, leaving the 50EX to reign at the top of the mid-size group. Similar to a heavy-iron aircraft, the 50EX excels at long-range, over water missions because of its range performance, systems redundancy and proven reliability.

Now that it's capable of climbing directly to FL 410, cruising at 0.80 IMN and flying eight passengers more than 3,000 miles, only heavy-iron can fly faster, farther and offer passengers more cabin volume.

Dassault may not have discovered the elixir of youth among "les bains," but the firm's engineers clearly infused the 50EX with new speed, vitality and sophistication. Ultimately, the market will vote on how well Dassault succeeded in rolling back the clock, by casting ballots in the form of $16-million-plus purchase orders. ■

By Fred George