B/CA Analysis: IAI Westwind 2

By incorporating improved aerodynamics and advanced avionics, Israel Aircraft Industries maintains the tradition of offering a lot of corporate jet for the dollar.

By John W. Olcott

How does a manufacturer enhance an aircraft that presently enjoys the reputation for possessing a favorable price/performance ratio? Israel Aircraft Industries addressed that question when it sought to improve its Model 1124 Westwind 1, and found the answer it wanted by judiciously applying advanced technology to create the Model 1124A Westwind 2.

When operators of Westwinds are asked what attracted them to the aircraft, most often they respond with comments about the 1124's favorable ratio of price to cabin volume, passenger comfort and range. Almost to the person, they refer to the aircraft as a lot of transportation for the dollar, which in the final analysis is high praise for any aircraft. Improving upon that reputation without incorporating extensive changes in configuration requires considerable ingenuity.

Ingenuity, however, is Israel Aircraft Industries long suit. IAI engineers have developed innovative applications of advanced aerodynamics and avionics to the design to provide increased performance and utility in the Westwind 2 while retaining the aircraft's image of being a good buy, even though the improved air craft costs about $650,000 more than the identically sized Model 1124.

Winglets are the most obvious difference between the Westwind 2 and its predecessor. In fact, the Westwind 2's winglets look quite different from similar aerodynamic surfaces found on other aircraft, such as the Gates Learjet Longhorn series and the Gulfstream American G-III. Unlike the Gates Learjet Model 28 and 29, which eliminated the 20 Series' classic tiptanks when winglets were incorporated, the Westwind 2 retains the Model 1124 tiptanks and adds winglets as appendages that extend from the tanks' upper surface at a 15-degree angle.

Skeptics may dismiss the Westwind 2's unusual application of wingletted tiptanks as merely a marketing ploy designed to attract attention to the aircraft, but such cynicism is unwarranted. Wind tunnel tests revealed that locating the winglets on the tanks not only improved the lift-to-drag ratio of the Westwind, but the presence of the tiptank improved the effectiveness of the winglet. Engineers determined that the effective length of the winglet was longer when it was situated on the tank since the tank itself provided some of the beneficial effects of repositioning the wingtip vortex. Furthermore, the presence of the tiptank somewhat reduced the sensitivity of the winglet to its location and orientation on the wingtip, and no loss of fuel capacity was suffered as was the situation when Gates Learjet's engineers choose to eliminate the tiptanks on the Models 28 and 29.

At first, flight tests of the Westwind 2 did not confirm the benefits in reduced drag that wind tunnel studies had predicted. By tufting the region around the juncture of the winglet, tank and wingtip, IAI's engineers discovered an area of separated airflow on the inside, lower portion of the winglets. When vortex generators were employed in that location, however, the high-drag, separated airflow was eliminated and the predicted performance improvements of the winglets were realized in flight.

A More Subtle Difference

Winglets are not the only aerodynamic difference between the Westwind 1 and 2. A more subtle change was made to the Model 1124A's wing by eliminating the droop that was employed initially when the 1121's wing was modified to the 1123 configuration. That droop was further enhanced when the 1123's wing was improved for the 1124. The Model 1124A's wing incorporates an entirely new leading-edge radius, or shape, that modifies the upper surface of the wing from its leading edge to about 40 percent of its upper chord.

The new wing, which retains much of the shape of the original 1121's 64A212 airfoil except for its new leading edge and upper surface, was developed by IAI engineers using the latest techniques in computational aerodynamics and computer-aided design. High-speed drag is reduced, and the maximum lift coefficient (CLNIAX) is increased by about three percent, compared with the Model 1124 wing. The CLNIAX of the Westwind 2 wing with flaps fully down is 1.85.

As a result of the winglets and modified airfoil, the Westwind 2 exhibits improved characteristics in several areas. Its drag coefficient is about 0.0025 to 0.0035 less than the Westwind I's figured at similar Mach numbers. For example, at a weight of 18,000 pounds cruising at 0.76 Mach at FL 330, the Westwind 2 exhibits a drag coefficient of 0.0305, compared with a CD of 0.0335 for the Westwind 1. That drag reduction translates into nearly a 10-percent increase in lift-to-drag ratio, a prime factor in cruising efficiency.

The Westwind 2's wing, which IAI calls its Sigma wing, expanded the aircraft's Mach, to 0.80, compared with 0.765 for the Model 1124. It also eliminated a slight Mach tuck that the Westwind I experiences between 0.73 Mach and 0.76 Mach, and it improved the aircraft's overall pitch characteristics.

Consequently, the Model 1124A enjoys an expanded center-of-gravity envelope; at its max ramp weight of 23,650 pounds, the Westwind 2 legally can be loaded to a c.g. of 31 percent mean aerodynamic chord, compared with 30 percent for the Westwind 1.

The Sigma wing allows the Westwind 2 to have a higher takeoff weight than the Westwind 1 (23,500 pounds as compared to 23,000 pounds), reach an initial cruise altitude that is about 2,000 feet higher and cruise with a specific range that is about five percent greater. Because the Westwind 2 can cruise about 2,000 feet higher than an equally loaded Westwind 1, the new model actually experiences an increase in specific range of about 7 to 8 percent.

On a hot day, the Westwind 2 enjoys about a 1,500-pound advantage in useful load because of improved second-segment climb performance, compared with the Model 1124. Balanced field lengths for the two Westwinds are identical, however, because IAI felt that the slight reductions it might be granted (on the order of 50 feet) would not warrant the additional time and cost of conducting the required tests for certificating a flight manual change.

Since the Westwind 1 and 2 each use the same powerplant — the Garrett TFE731-3-1G rated at 3,700 pounds thrust — the performance increases are due to the aerodynamic contributions of the winglets and recontoured wing. Those changes were accomplished without extensive structural modification (although some additional structure near the outboard portion of the forward spar was needed to carry slightly higher tip loads), thus the cost and time in developing and certificating the Westwind 2 were reasonable. Furthermore, the recontoured wing holds about 1.5 percent more fuel.

Yes, IAI engineers exhibited considerable ingenuity in producing the Model 1124A Westwind 2.

Operational Characteristics

While the winglets play an important part in the improved performance of the Westwind 2, they induce more Dutch roll, particularly at altitude. The yaw-rolling oscillation is not uncomfortable, but is prominent when the aircraft is hand flown. Dutch roll is not observed when the autopilot or yaw damper is engaged, however.

The aircraft can be dispatched legally to its maximum approved operating altitude of FL 450 with either the yaw damper or autopilot inoperative. If both systems are out, however, the AFM states that the Westwind 2 be limited to FL 200.

B/CA flew the Westwind 2 for prolonged periods at altitudes up to FL 410 without either system engaged. While the Dutch roll was noticeable and required some attention by the pilot, the work load was not excessive.

In addition to influencing the Dutch roll, the winglets also affect aileron control power. Since the winglets cause more aerodynamic load to be carried near the wingtips, the effectiveness of the ailerons is increased. Because the Westwind I is considered to have satisfactory roll control, that winglet-induced characteristic is a pleasant but unnecessary plus in the Westwind 2.

However, range/payload capabilities, rather than handling qualities, are the Westwind 2's most significant operational characteristic. B/CA had the opportunity to experience the aircraft's best feature — range — during a delivery flight from IAI's factory outside Tel Aviv to Wilmington, Delaware, home base of Atlantic Aviation Corporation, U.S. distributor for the Westwind 1 and 2.

The Model 1124A easily made the flight, which included stops in Rome, Shannon, Keflavik, Iceland and Goose Bay, without undo attention to routing or any other special considerations. For the longest leg — Keflavik to Goose Bay — the Westwind 2 departed Iceland with three souls on board and full tanks, which contained 9,720 pounds of fuel since the outside air temperature was a cool -10°C. (The normal tanks-full load under ISA conditions is 9,580 pounds.)

With a max-gross-weight takeoff, the aircraft climbed to its initial altitude of FL 370, where conditions were ISA+ 10°C, in 23 minutes, and settled into a 0.70 Mach cruise. As the aircraft became lighter and we reached slightly cooler (ISA+60°C) air, the Mach number edged upward toward 0.76 Mach. Three hours into the flight, the aircraft had consumed slightly less than half its fuel load and was easily achieving 0.76 Mach with a total fuel burn of 1,410 pounds per hour at FL 370 under ISA + 60°C, conditions.

Upon landing at Goose Bay, 3+36 after departing Keflavik, the Westwind 2 still had 4,180 pounds of fuel remaining. Had the aircraft been equipped with dual long-range navigation equipment, we could have used one of the North Atlantic tracks and avoided Iceland entirely.

More than Aerodynamics

Good specific range, due in part to the aerodynamic improvements IAI incorporated in the Westwind 2, is but one characteristic that adds to the operational flexibility of the Model 1124A. Another noticeable feature is the Collins FMS-90 flight management system, which is standard on all Westwind 2s and accounts for a sizable portion of the price difference between the new aircraft and its predecessor.

Since B/CA published a detailed review of this avionics package in November 1981 ("Collins FMS-90 Debuts in Westwind 2," page 74) we will not elaborate on the system here, but the unit (which manages the aircraft's entire avionics system and allows long-range, VLF/omega-based navigation to be integrated with VOR/DME navigation) worked well and enhanced the ease with which the flight was made.

Although Atlantic Aviation pilots who routinely fly the FMS-90 in Westwind 2s say that as many as 40 hours are consumed before an operator feels totally at home with the system, they speak highly about the advantages of having so much avionics capability available from one, integrated package.

The standard avionics package or the Westwind 2 also includes several other advanced units from Collins. The aircraft comes equipped from the factory with the FCS-80 flight control system, the FDS-85 flight director, the APS-80 autopilot and the RNS-300 radar navigation system. IAI is certified to install and service these units in Israel.

Since the Westwind 2 enjoys a healthy range capacity, many operators choose to install a second long-range navigational system in order to meet the minimum requirements for use of the North Atlantic organized track structure.

The B/CA Comparison Profile also indicates that the appeal of the Westwind 2 is more than just its range. To generate the Profile, we compared the Model 1124A against a theoretical aircraft comprised of the average characteristics of the Westwind 2, Learjet 35A, Falcon 10, HS 125-700 and Sabre 65, a group that includes all of the Garrett TFE 731-powered aircraft except the Citation III and the Model 55 Learjet.

Since the Westwind traditionally has competed against larger aircraft, such as the HS 125-700 and Sabre 65, in addition to smaller, swifter jets, the model 1124A eventually may do battle with Cessna's and Gates' new, standup-cabin entries. That comparison, however, must wait for a future analysis by B/CA, particularly since lead times for delivery of Citation IIIs and Model 55s probably preclude a market confrontation with the Westwind 2 at this time.

The Model 1124A compares well to our theoretical aircraft in the area of passenger comfort and accommodation, ranking above average in seating, pressure differential, cabin size and load-carrying capability. The Comparison fails to show, however, the aircraft's ample baggage volume. Operators rarely find any need to carry luggage in the cabin, even with a full load of passengers on board.

Except for the items that relate to range, performance numbers for the Westwind 2 fall near or below the average. Examples are airport performance, particularly under hot and high conditions. But the Model 1124's overall performance remains attractive compared to its price line.

The three performance graphs present a visual summary of the Westwind 2's range/payload characteristics as well as its specific range at various altitudes and speeds. These charts give added meaning to the Comparison Profile since they show in greater detail the aircraft's impressive range and identify the tradeoffs in runway requirements.

In terms of dollars, the Westwind program represents the largest single source of

Israeli exports to the United States, and Israel Aircraft Industries seems intent on maintaining that record with the Westwind 2's range/payload characteristics as well as its specific range at various altitudes and speeds. These charts give added meaning to the Comparison Profile since they show in greater detail the aircraft's impressive range and identify the tradeoffs in runway requirements.

Neither these performance graphs nor the Comparison Profile present the whole story, however. Although very important, price and performance are only two elements in the selection decision. Research has shown that a manufacturer's reputation and product reliability are among the most important considerations in the selection process, and that product support is a major factor in a purchase decision, particularly for an aircraft manufactured as far away as Israel.

IAI's answer to the service question was found about 10 years ago when it appointed Atlantic Aviation Corporation as its marketing arm for business jets in the United States. Atlantic Aviation stocks $4 million in Westwind spares and enjoys a reputation of being a first-class operation. IAI also maintains eight service representatives in the United States who are based at several locations throughout the country. IAI has an engineering capability situated in Oklahoma City and an administrative office in New York City.

Furthermore, IAI is the parent firm for Bedek Aviation, a 3,500-person service organization located next door to the factory where Westwinds are manufactured. Communications between Westwind engineers and Bedek service specialists are open and effective, and in fact have led to several solutions to problems that were uncovered by operators.

For example, working with Bedek people, IAI developed a means of attenuating the pulses that had caused hydraulic leaks in several of the early Westwind Is. The Model 1124 and 1124A now use an attenuator that originally was designed for the McDonnell-Douglas F-4, an aircraft that Bedek services for the Israel Air Force.

Good rapport between IAI and the working level within Bedek is aided by the person who is the top service engineer on the Westwind program. Previously he had been with Bedek for 15 years, spending several of them as chief inspector.

Israel Aircraft Industries also uses U.S. vendors for most major components for the Westwind 2, even though it is capable of fabricating many of them in Israel. But when factory parts are required, El Al (the Israeli airline) provides 24-hour delivery of AOG items.

In terms of dollars, the Westwind program represents the largest single source of Israeli exports to the United States, and Israel Aircraft Industries seems intent on maintaining that record with the Westwind 2. B/CA