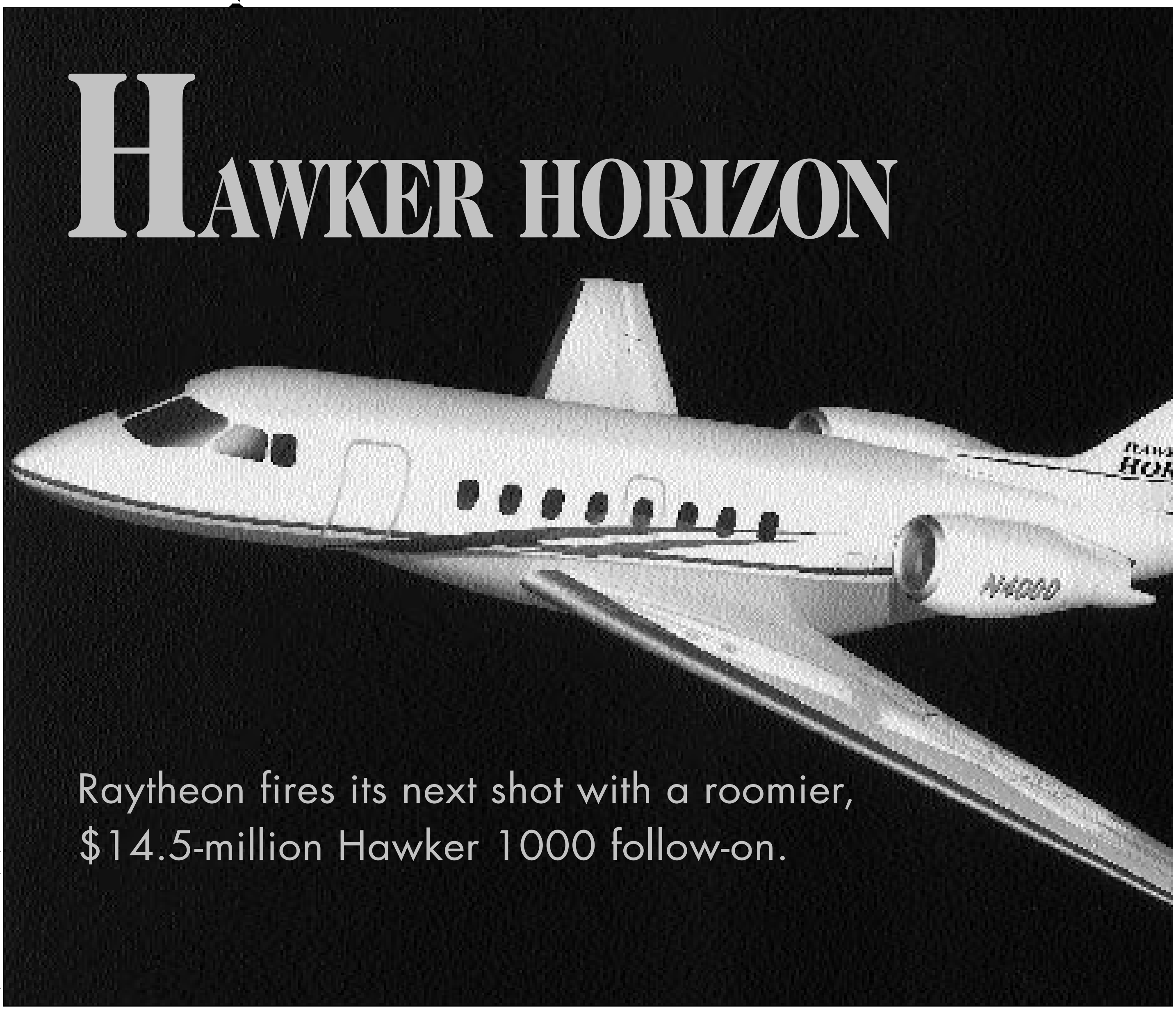

HAWKER HORIZON

Raytheon fires its next shot with a roomier, $14.5-million Hawker 1000 follow-on.

Raytheon Aircraft Company

Having two totally new aircraft on the boards at the same time is almost unprecedented in the business aircraft industry. In the case of Raytheon Aircraft Company (née Beech) decades once separated clean-sheet turbine airplanes. The Starship was announced in the mid 1980s, and before that you have to go all the way back to the inception of the King Air in the early 1960s to find a new turbine aircraft, and even it was a derivative of the 1950s-vintage Queen Air. Times have changed.

In 1995, Raytheon Aircraft announced the Premier I, a totally new aircraft that the company hopes will redefine the light jet market. Now, less than 12 months later, the company has unveiled its next new aircraft—the Hawker Horizon.

The follow-on to the Hawker 1000 stakes the company's future on the new technologies that defined the Premier I. The Horizon will have a composite fuselage manufactured using the same advanced automation employed in building the Premier I. And like the smaller aircraft, the Horizon also will have metal wings, this time designed and manufactured with Fuji Heavy Industries.

The new technology is not being employed for technology's sake. In-stead, composites are the means for producing aircraft that offer performance at a price Raytheon believes its competitors can't match using conventional manufacturing techniques, according to Raytheon Aircraft President Roy Norris.

"In order to meet the performance and price set-points we're talking about, you cannot build aircraft out of aluminum," Norris says. "Once you change the set-points, there's only one way to get there, and that's with composites."

The Horizon won't be the fastest in its class, nor will it have the longest legs. "What we do want to win hands down is to be substantially above the competition in the mixed consideration of speed, range, price and cabin

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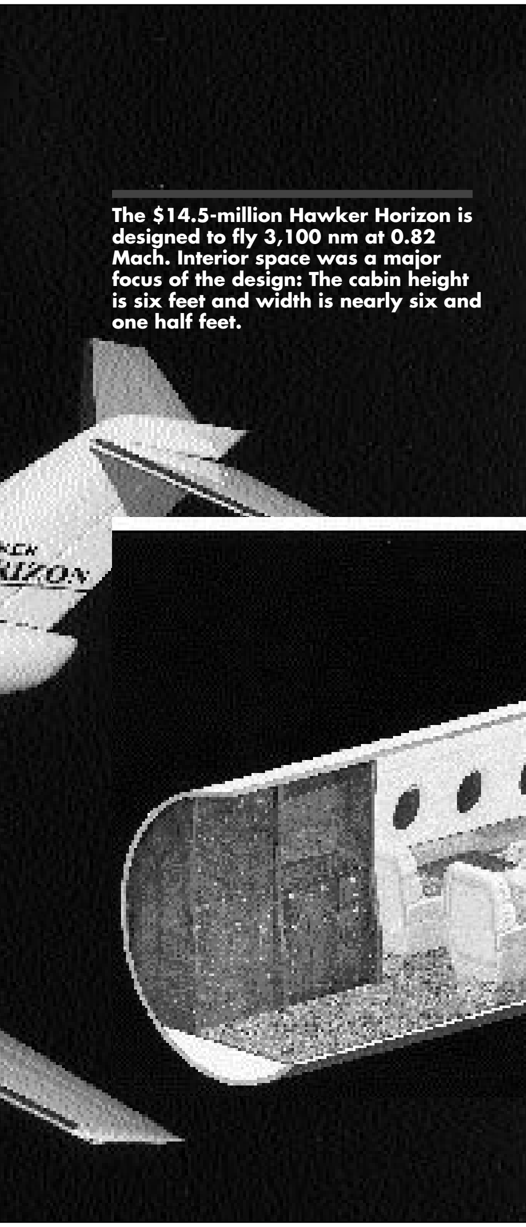
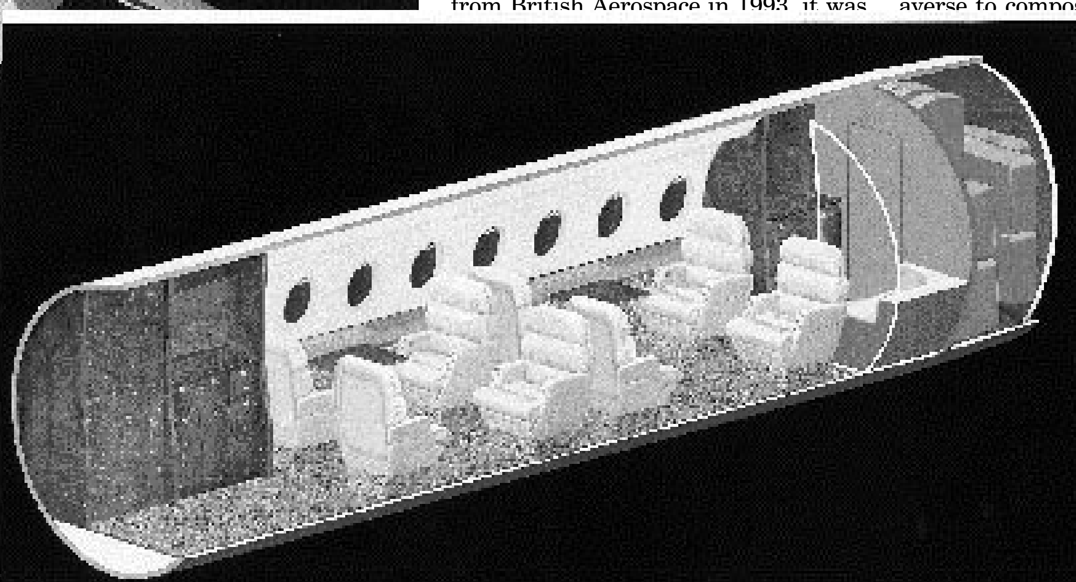


The $14.5-million Hawker Horizon is designed to fly 3,100 nm at 0.82 Mach. Interior space was a major focus of the design: The cabin height is six feet and width is nearly six and one half feet.



size," Norris says. Scheduled for its first flight in late 1999, the Horizon, powered by new Pratt & Whitney Canada PW308As, will carry six passengers 3,100 nm at 0.82 Mach with NBAA IFR reserves. The eight-place cabin will be 77 inches wide, and will be nearly 22 feet long. The price is $14.5 million in 1996 dollars, and the direct operating cost target is about $1,000 per hour ($467 for fuel and $544 for maintenance). Absent new design and manufacturing techniques, the aircraft would have come to market at $18 million in 1996 dollars, Norris asserts.

The company is uncompromisingly optimistic that composite technology will open a gap between its aircraft and competing designs that will take years for other manufacturers to close. Norris calls the Horizon "the next bullet out of the gun," and says there are at least two more cartridges in the magazine: a follow-on to the Premier I that will be launched in a year to compete with the Learjet 45, and in 1998, another new aircraft—quite possibly a new-technology turboprop. He also isn't closing the door on a small regional jet, which could be derived from the Horizon's basic design.

MARKET FOCUS

When Raytheon acquired Hawker from British Aerospace in 1993, it was

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800s have sold in the 12 years since its debut, and no end is in sight. The newer 1000 is now out of production; 52 1000s made it to market, nearly half of which are operated in the NetJets program.

From the time of the Hawker acquisition, Raytheon began exploring follow-ons to the 1000. The company considered re-engining, stretching the fuselage, redesigning the wing, and retrofitting a new avionics package. All of those ideas were scrapped as fixes that fell short of the company's more ambitious vision.

"It became evident in the final analysis that a modification wouldn't be a new product that would lead us into the next century," Norris says now. "If we really wanted to make a quantum jump forward, we really needed to start with a clean sheet of paper."

To shape the product, Raytheon convened five customer focus groups—three in the United States and two elsewhere. They probed the market in an effort to strike the proper balance of performance, comfort and price. The groups listed range and price as top considerations, saying they wanted everyday transcontinental range and the capability to make occasional transatlantic trips, and they wanted acquisition and operating costs as low as possible.

To define the product further, the groups were asked to make tradeoffs. For instance, would they pay $2 million more for an aircraft that cruised in the 0.88 Mach/0.89 Mach range? The answer was no. Would they be averse to composites, if the result was

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zon is that aircraft, and if the program meets its spec, the aircraft will be impressive.

The targeted $14.5-million price will make the Horizon a tough competitor for the Citation X and the Falcon 2000 and 50EX. Its range is roughly equal to that of the 50EX, and it will outdistance either the X or the 2000. While the speedier X is closest in price at $15.3 million, its cabin is considerably smaller. The Falcon 50EX is a good match for size, but costs about $1.5 million more, and while the Falcon 2000 easily wins the race for elbowroom, offering a cabin that is more than a foot wider than the Horizon, it carries a price tag some $3.6 million higher. Only the Astra SPX can fly as far for less money, and it has a much smaller cabin. However, the larger Astra Galaxy, provided it meets its goals, will be an able competitor.

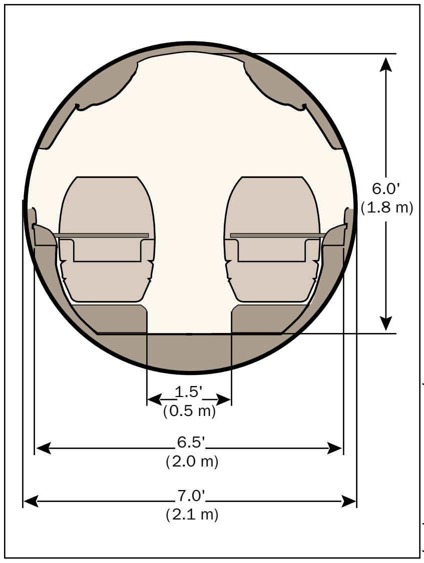
THE NEW HAWKER

The Horizon's similarities to its Hawker kin will be comparatively few. The aircraft will preserve the distinctive airscoop that translates smoothly into the vertical stabilizer—a Hawker hallmark since the first HS-125s hit the market in the fall of 1964. In the cockpit, the Hawker's ram's-horn control yokes will carry through to the new airplane, and designers are charged with making the Horizon "feel" like a Hawker, which is to say benign and easy to fly. Other than that, it will be all-new.

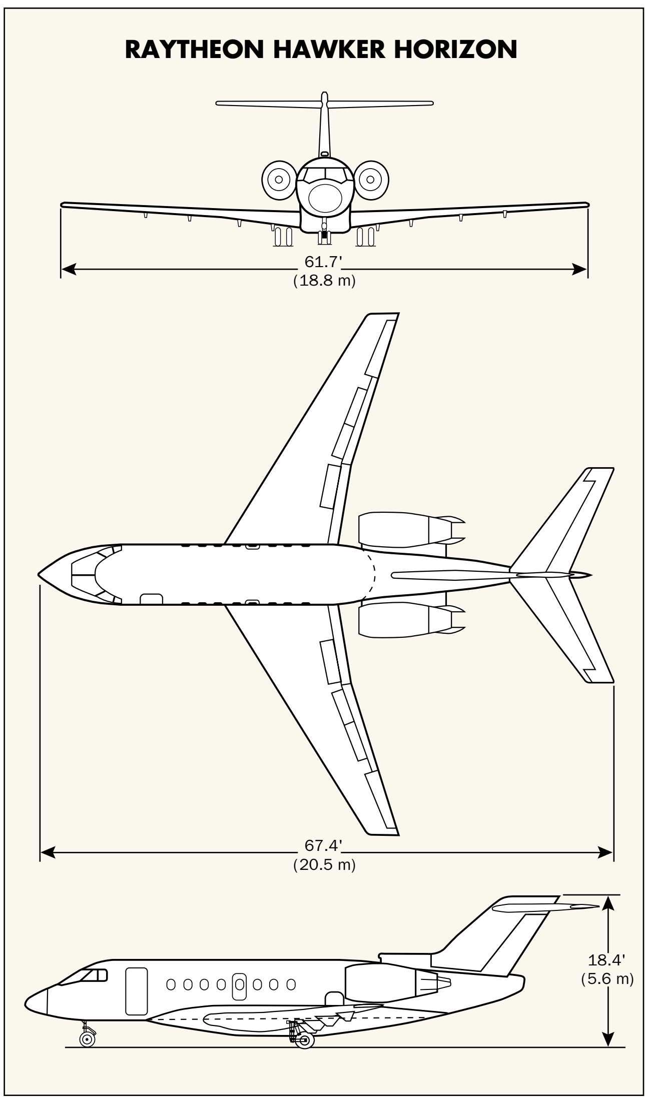
The Horizon will be a substantially larger aircraft than the 1000. Overall length is up 14.5 feet to 67.4 feet, translating into a longer passenger cabin, more baggage space, and a more refined taper to the area-ruled aft fuselage for improved aerodynamic performance. The longer fuselage also increases clearance between the engine inlet and the wing's trailing edge, another aerodynamic improvement. The span of the one-piece wing is up just over 10 feet to 61.7 feet, while height is 18.4 feet, compared to 17.1 feet for the 1000. Furthermore, the wing carry-through is all under the cabin, leaving the aircraft with a flat, uninterrupted cabin floor from the cockpit aft to the baggage compartment.

Perhaps the strongest selling point of the 1000 was its generous cabin. The Horizon goes that one better, boosting space in every dimension, and scrapping the 1000's side-facing divan for a basic eight-seat, two-club configuration. Directly opposite the 65-inch-high door is the central avionics bay, which houses the brains behind the new Honeywell Epic five-screen avionics suite. (See "Honeywell's Epic Avionics Suite" sidebar.) The entry area also accommodates the galley as well as storage space.

Aft of the entry is the two-club main cabin, which at 16.3 feet is nearly three feet longer than that in the 1000. The center aisle is unobstructed, and the floor is flat throughout. (See accompanying illustration.) The aft wall of the lavatory is a secondary pressure bulkhead that includes a door to the main baggage compartment, which has more than doubled in size to 110 cubic feet. External access to the baggage bay also has been improved by virtue of the longer fuselage, which leaves more room between the inlet and wing. The sill of the baggage door is level with the baggage compartment floor for easy loading, and the door also is larger than it is on the 1000.



Source: Raytheon Aircraft Company



Source: Raytheon Aircraft Company

Because it is larger than the 1000, the Horizon also is a heavier airplane, although it has more payload capacity. The MTOW is 36,000 pounds, a 5,000-pound increase. Basic operating weight (including crew and supplies) is 20,930 pounds, an increase of just under 3,000 pounds. The Horizon will carry 14,000 pounds of fuel—up from 11,440 pounds in the 1000—all in the wet wings with single-point refueling. The tanks are segregated at the fuselage centerline, and fuel management should be a no-brainer: Each tank feeds one engine, with cross-feed provisions for single-engine operations.

Fill up the tanks, and the aircraft will haul 1,270 pounds, enough for six people and bags. Tanks-full range is 3,100 nm at 0.8 Mach, and range climbs to more than 3,400 nm at 0.76 Mach. Alternatively, with a 3,570-pound maximum payload (substantially higher than the 1000's 2,300 pounds), the aircraft will hold 11,700 pounds of fuel and will fly just under 2,400 nm with NBAA IFR reserves.

The PW308A engines that power the Horizon are scaled-up versions of the PW305s on the Hawker 1000. The 308A's core is 20 percent larger than the PW305's; however, mass flow is increased 30 percent compared to the smaller engine, and specific fuel consumption is seven percent better. (See "Pratt & Whitney's New PW308A" sidebar.)

The 6,500-pound-thrust engines will propel the Horizon direct to FL 410 in an estimated 20 minutes at MTOW, and the aircraft will be certificated for operations up to FL 450, where the pressurization system will maintain a 6,000-foot cabin altitude. P&WC will supply Raytheon with a propulsion package that includes a Nordam nacelle and thrust-reverser system.

The forward fuselage also has been reshaped. The nose is rounder, and the rake of the windows has been increased for smoother flow, which results in both a roomier and quieter cockpit. Analysis shows that "Mach rumble" over the cockpit crown should be reduced by the new shape, which yields a 0.2 Mach reduction in speed of transonic flow over the crown as well as a better shockwave profile.

Raytheon is guaranteeing a 5,250-foot (+/-3 percent) balanced field length at MTOW on a standard day at sea level. End-of-mission (24,000 pounds) landing distance is guaranteed at 2,340 feet. Operating from a 4,000-foot runway with a 1,200-pound payload, the Horizon will fly a 1,900-nm mission with NBAA IFR reserves. Max speed is 0.84 Mach.

PRATT & WHITNEY'S NEW PW308A

While the new Hawker's powerplants have roots in the PW305s on the Hawker 1000, the newest version is nearly as different from its forebear as the Horizon will be from its predecessor.

Pratt & Whitney Canada went back to the drawing board for the Horizon, prevailing in a hard-fought battle against Allison and CFE (the joint venture between AlliedSignal and General Electric that produces the CFE738 that powers the Falcon 2000). When the dust settled, Raytheon selected the new PW308A, a scaled-up version of the PW305 that will produce 6,575 pounds of thrust at takeoff, and some 1,489 pounds at 40,000 feet and 0.8 Mach.

The 308A's strongest suit is margin—boatloads of it. The engine's thermodynamic capability is actually 8,000 pounds of thrust (hence the 308 designation), so it is substantially derated for the Horizon. The result is substantial flat-rating as well as durability. Takeoff thrust will be maintained to a whopping ISA+20°C at sea level. The engine is designed to have a 3,000-hour hot section inspection interval and a 6,000-hour TBO right out of the box.

Typically, engines have restrained maintenance intervals at introduction. For instance, the 305's TBO was 2,500 hours initially, and was boosted to 3,500 hours as hours were built by the fleet. The mature target is 4,500 hours. However, with the 308A, Pratt & Whitney has changed the way it will test its engines during development so they will debut with mature maintenance intervals. The company also says it will work toward moving the engines to on-condition status, which means no hard life limits.

At the heart of the PW308A is a 20-percent scale-up of the PW305's core, which includes four axial stages and one centrifugal compressor stage. (The new core is common to the PW150 turboprop that is being developed for the de Havilland Dash 8-400 and other 70-seat-class regional airliners.)

In addition to upscaling, P&WC improved sealing and aerodynamics in the core, and the net result is 30 percent more mass flow and a seven percent improvement in specific fuel consumption compared to the 305. Takeoff thrust SFC will be 0.382 pounds per shaft horsepower per hour, while cruise is 0.638 at 40,000 feet and 0.8 Mach. The titanium fan has 22 snubberless, shroudless blades and is 33.2 inches in diameter, compared to 30.9 inches on the PW305. Bypass ratio is 3.88.

As with the Horizon airframe, the dual-channel FADEC-equipped 308A is being designed with maintainability in mind. Hot-section inspection can be done on the aircraft, engine-mounted accessories are all line-replaceable, and the engine is fitted with borescope access points to limit exploratory surgery. The FADECs make possible an automated trend-monitoring system and an integrated engine diagnostic system as well. P&WC plans to back the engine with a five-year, 3,000-hour full warranty with no proration, and also will offer a tailored Eagle Service Plan fixed hourly operating cost program for the engine.

First runs of the engine are expected in early 1998. In addition to supplying powerplants, P&WC is the engine-systems integrator on the Horizon, and plans to work with Nordam to develop the nacelle and thrust reverser for the 308A. Pratt will deliver ready-to-install engine assemblies to Raytheon.

SYSTEMS AND CONTROLS

The wing, empennage and basic-systems architecture of the Horizon were conceived and designed to accommodate both the Horizon and future new aircraft, according to Norris. Major systems upgrades include the addition of an APU certificated for inflight operations and dropping the TKS weeping-wing anti-ice system in favor of a bleed-air system for both the wings and empennage.

The all-metal, single-piece, underslung wing was defined by Raytheon, but will be manufactured by Fuji Heavy Industries, which prevailed in bidding against potential U.S. and European competitors, including British Aerospace. Although the basic design is set, Fuji, which builds the Boeing 777 center fuselage, will do the detailed design work on the wing. Raytheon was aggressive in the bidding process, and has agreements that shift some design and integration work to partners like Fuji, P&WC and Honeywell. However, the partnerships are fairly conventional when it comes to financial arrangements. Unlike full risk-sharing partners, suppliers will not get a percentage of revenues and will, instead, be paid like suppliers.

With just under 29 degrees of sweep, the supercritical wing is designed to blend high- and low-speed characteristics and has no leading edge devices. The trailing edge has inboard and outboard slotted flaps. Forward of the inboard flap is a lift spoiler, and two roll spoilers are situated forward of the outboard flap.

The flaps will be electrically operated, and the spoilers will be electrically signaled. However, both ailerons and the elevator will be manually controlled with cables, bellcranks and pulleys for simplicity and reduced maintenance. The single-piece rudder will be powered either electrically or hydraulically, depending on the outcome of ongoing design work. The empennage is all metal and includes a flying horizontal stabilizer for pitch trim.

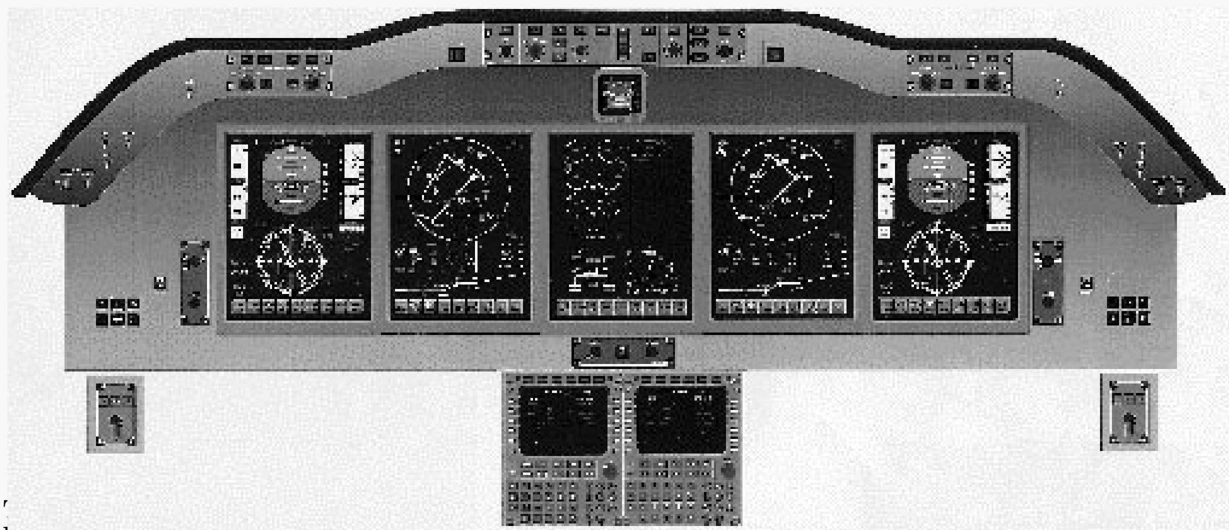
While no vendor has been named for the landing gear, the basic design has been laid out, including trailing-link mains for smoother landings. A conventional nose gear with increased steering authority—60 degrees versus 45 degrees—should yield approximately the same turning radius as the Hawker 1000. A digital anti-skid system will be standard.

Raytheon also is in the process of selecting a vendor for the electrical system, although the basic architecture is set and will include engine-driven variable-frequency 30kVA generators and an APU-driven generator. The APU will be certificated for operation at up to 41,000 feet, and will be air-start capable at up to approximately 35,000 feet. Emergency power can also be supplied by a 5kVA, hydraulically-driven generator. Battery power will be supplied by two 42-amp-hour nickel cadmium batteries with a dedicated charger. The aircraft can take both AC and DC external power.

MAINTAINABILITY

One of the benefits of using operator advisory teams and integrated product teams in designing aircraft is that maintenance and product-support considerations are given voice early in the design phase. "We're trying to end up with an airplane that the customer

HONEYWELL'S EPIC AVIONICS SUITE



Raytheon Aircraft Company

launch application for Honeywell's new Primus Epic avionics system. But equally significant is the extent to which Honeywell will be integrating, and even controlling, basic aircraft functions.

The cockpit will center around five eight-by-10-inch flat-panel liquid crystal displays, including two primary flight displays, two multifunction displays, and an engine indication and crew alert system (EICAS) display with seven synoptic pages for various aircraft systems.

Where the system departs from the norm is that in addition to displaying the status of a system, the synoptic displays also will serve as an interface that enables pilots to actually control the systems. For instance, the electrical system display will not only show the status of individual components, it also will enable pilots to shut down a malfunctioning generator.

Horizon is a fitting application for Epic, because the philosophy behind both programs is the same—adapting new technology to business aviation systems in order to both decrease cost and increase performance. The system will be based on aviation grade, off-the-shelf chips, and individual components will essentially function like a network of high-power personal computers linked by a local area network. (See B/CA, November 1996, page 116 for complete details on Epic.)

Honeywell intends to trim 30 percent of the acquisition cost, reduce weight and volume by 40 percent, cut wire count by one-third and slash application functions (such as FMS and display symbol-generation) by one-half, compared to today's Primus 1000 and 2000 systems. Honeywell's goal is to double reliability while im-

graded diagnostics and malfunction logging.

The list of standard equipment for Horizon is extensive and includes a Primus II Nav/Comm suite, dual air data system, dual inertial reference system, single GPS sensor with additional sensors optional, dual FMZ-2000 FMS, dual autothrottles and dual automatic flight control system.

For weather detection, the aircraft will be fitted with a Primus 880 radar and a lightning detection system, and the displays also will be capable of displaying radar maps received via datalink.

TCAS II will be a standard fit, and AlliedSignal will supply its enhanced GPWS as well as solid-state cockpit voice recorder and flight data recorder for integration by Honeywell. Other AlliedSignal-furnished components include a Flitefone 800 and a single HF comm.

can use, and use hard, without any warranty problems," says Raytheon Aircraft Chairman Art Wegner.

Among the advantages of composite construction is that corrosion becomes a non-issue in the primary fuselage structure. The elimination of TKS from the wings and empennage also should reduce corrosion problems there.

The aircraft will be backed by a five-year warranty, and the powerplants will have 3,000-hour hot-section inspection and 6,000-hour TBO intervals out of the box. By moving all avionics components into racks in the cabin, avionics reliability should be enhanced, and maintenance should be easier, because like the aircraft itself, Honeywell designed for accessibility and maintainability. The Honeywell system includes a standard-maintenance data computer. A portable terminal for accessing maintenance information will be included as standard equipment.

With the exception of hydraulic lines (which run outside the pressure vessel), most control cables, plumbing and wiring will run under the center aisle and will be accessible without removing the seats. The batteries and electrical panels are located aft of the wing in the under-body fairing and can be accessed from the ground. The ECS packs and hydraulic pumps are accessible through the hell hole, and the APU is reachable by removing the tailcone.

Raytheon attributes much of its new thinking on maintainability to its Beech MkII, the modified Pilatus PC-9 that prevailed in the hotly contested Joint Primary Aircraft Training System (JPATS) military trainer competition. Indeed, JPATS proved in many ways to be a watershed for the company. It was on that program, and the subsequent Premier I, that Raytheon developed and honed its team-oriented approach to designing and manufacturing aircraft.

It is difficult to overstate the extent of the renewal at Raytheon, from the name down to the company's facilities in Wichita. Beech aircraft was once guided from "Mahogany Row," a suite of executive offices presided over first by Walter and then Olive Ann Beech. Raytheon took over in the early 1980s, but with the exception (and mixed results) of the Starship program, the button-down, old-line philosophy continued to guide—and define—the company.

That's not true anymore. Mahogany Row is gone. In its place is the new management team of Roy Norris and Art Wegner, who steer the renamed company from a spanking new headquarters building. Old ways of designing have given way to integrated product teams, manufacturing processes have been redesigned, and new manufacturing facilities are under construction. Ideas flow from a new research and development building, and the company recently helped pay for a rerouting of Wichita's Central Avenue to accommodate construction of a new 8,000-foot runway.

And, of course, there are the two new programs—Premier I and Hawker Horizon—with others to come. If the first two "bullets out of the gun" find their intended mark, Raytheon's competitors may well find themselves wondering if they've walked into a machine-gun nest. ■

By Perry Bradley

MAKING COMPOSITES PAY

The key enabler for the Hawker Horizon and the Premier I programs is Raytheon's move toward highly automated composite construction. If the Starship was an opportunity for the company to cut its teeth on composites, the new programs show signs that Raytheon's wisdom teeth are coming in. The difference boils down to automation: The Starship was essentially hand-built; the new airplanes are largely built by an industrial robot.

Rather than conventional jigs and tooling, Raytheon's up-front cost and development for the Premier I and Horizon fuselages is largely in building the molds for the major composite shapes. A "positive" mandrel made of polished aluminum is the basis for lay-up, while a clamshell "negative" holds the parts as they are cured in Raytheon's massive kilns.

Carbon fiber tape—made up of strands of individual resin-impregnated fibers—are laid up automatically by a Cincinnati Milicron "Viper" fiber-placement system with seven axes of movement. The machine can be programmed to cut and restart lay-up—leaving a blank for a window, for instance—and can also change the direction of lay-up so that individual layers work together to make a stronger structure. A one-inch-thick Nomex honeycomb layer and frames for window and door openings are then placed on the mandrel by hand. Finally, the Viper system wraps an outside layer of carbon fiber tape around the mandrel.

Once lay-up is complete, the clamshell is placed around the basic structure. Air is forced between the mandrel and the carbon-fiber sandwich, forcing the fuselage against the composite clamshell, allowing the mandrel to be removed. Then, the fuselage sections are placed in the kiln for curing, which causes the resins to melt and merge, binding the individual carbon fibers together as one structure. By curing against the clamshell, a smooth exterior surface is ensured.

Once cured, the raw fuselage is placed in a jig, and a laser unit projects a template of cutouts onto the structure. A router is used to rough out the doors, escape hatches and windows. The last step is a non-destructive inspection using laser shearography to ensure there are no gaps or bubbles in between fiber layers or elements of the "sandwich." The end result is a fuselage thickness of just over an inch, compared to as much as eight inches in some areas of an aluminum structure, for instance around a door.

The Horizon will be built in three sections—nose, center tube and aft fuselage. Once the shapes are roughed out, workers will install the fittings necessary to build up internal and external structure. Each section will be "stuffed," to the extent possible, with wiring, ECS plumbing, control cables and the like before being joined.

By working on individual sections, access is improved, and work can be done concurrently, which yields additional cost and time savings. Ultimately, the three sections will be "glued" together with composite splices overlapping the butt ends of each section.