



Piaggio Aero P180 Avanti II

With more power, a Pro Line 21 cockpit and new interior, this second-generation Avanti is in a class by itself.

By Fred George

Ciao, paisano. If the new Avanti II had rearview mirrors, its pilots could watch every other turboprop business aircraft disappear in its wake. That's nothing new for the Genoa jet-prop. The first-generation Avanti, dating back to 1990, also could speed by all prop-driven competitors. The Avanti II, equipped with more powerful engines, just widens the lead by at least 10 to 15 knots. Pilots can expect maximum cruise speeds of 400 KTAS at FL 310 at mid-weights assuming standard-day conditions, according to Piaggio Aero's latest cruise performance numbers.

Talk about a speed mismatch. Racing an Avanti II with any other turboprop is like chasing a Ferrari with a fire truck. The King Air 350, for example, is more than 80 knots slower and it's the next fastest turboprop on

the market. The King Air 200GT, the latest version of the best-selling Beech King Air, is 90 knots slower even with its new -52 engines.

Pitting the Avanti II against today's entry-level jets is a closer speed competition. However, no VLJ can catch the Avanti II. The Eclipse 500 comes closest, but it's still 20-plus knots behind. The Avanti II is not as fast as vintage Learjets, but it is significantly quicker than first-generation Citations. The Citation SII was its closest competitor prior to the arrival of the 430 KTAS Citation V.

Most current-generation light and all midsize jets clearly are faster than the Avanti II. Only the CJ1+ is slower and then by less than 10 knots. But the P180 offers a midsize jet cabin cross-section at about half the price of a midsize jet. The Avanti II has a cross section similar to those of the Citation XLS+, Hawker 750 and Learjet 60. The jets' longer cabins, though, provide seats for two or three more passengers. Such typical midsize jets can

fly a 1,000-nm trip in 35 to 40 minutes less time than the Avanti II.

The Avanti II's trump card, however, is its virtually unmatched fuel efficiency among pressurized twin-turbine business airplanes. It burns half as much fuel as a typical midsize jet on a 1,000-nm trip. The Eclipse 500 indeed is the only pressurized twin turbine aircraft that squeezes more miles out of a pound of Jet-A, according to *B&CA's* May 2007 *Purchase Planning Handbook*. But that's like a Ducati competing against a Ferrari.

The P180's fast, fuel efficient design dates back to the first oil crisis in the mid-1970s. At that time, Alessandro Mazzoni, IAM Rinaldo Piaggio's newly appointed chief designer, dreamt of creating a midsize business aircraft having near jet speeds and better-than-turboprop fuel economy. He approached Rinaldo Piaggio with the P180 concept in 1979. Mazzoni got the go-ahead for preliminary design work, but the company

Photography courtesy of Piaggio Aero Industries

lacked the funds for full-blown aircraft development. Consequently, the Italian manufacturer formed a joint venture with Gates Learjet in the early 1980s to produce and market the aircraft. But the partnership fell apart in 1986 when Gates Learjet itself became cashed strapped. Undeterred, Piaggio succeeded in flying the aircraft in 1986 and earning a type certificate in 1990.

By then, the pinch at the pump long had relented and with an abundance of relatively cheap jet fuel available, business aircraft operators flocked to thirstier jets. Suddenly, turboprops — even one that was dramatically styled, super efficient, commodious and fast — were as passé as polyester leisure suits.

That was bad timing for Piaggio. The large-scale investment in the P180 program had sapped its resources to perilously low levels. Not having other aircraft in mass production to sustain its revenues, Piaggio fell into receivership in 1994 and filed for bankruptcy in 1998. Fortunately, the Ferrari and di Mase families led a consortium that purchased the assets of IAM Rinaldo Piaggio the same year. With a fresh infusion of capital, the company reemerged as Piaggio Aero Industries SpA and it has been on the upswing during the last decade.

The change in world oil prices and supplies since the early 1990s is one prime reason for Piaggio's rebound. With today's jet fuel prices soaring through \$5 per gallon at many places and perhaps reaching even higher in the near future, Piaggio's three-decade long emphasis on fuel efficiency is once again in vogue. Its virtually unsurpassed fuel efficiency has a considerable impact on direct operating costs. Just as importantly, people all over the planet, and particularly in the news media, are becoming more conscious about carbon emissions and their impact on global warming and climate change. The Avanti II, as a result, wins first place as the green machine of the business aircraft fleet. That's a title worth touting in many circles, including at shareholder meetings.

The Avanti II may be powered by turboprop engines, but it's a technological tour de force that has much in common with jets. Not only does it remain the fastest and most fuel efficient turboprop in production since its introduction in 1990, it also has the lowest cabin noise levels. It routinely cruises in the high thirties and it can climb to FL 410 at mid-range weights. A 9.0-psi pressurization system assures that the cabin altitude never exceeds 6,600 feet. There is a full-width, fully enclosed aft lavatory with optional freshwater sink. Similar to many light jets, the Avanti II has an electrically powered, vapor-cycle air conditioner that can be powered by GPU prior to engine start, thereby assuring a comfortable cabin for the passengers before and after the flight.

Aerodynamics, Structure and Systems

Mazzoni knew in the late 1970s that given the state of technology of existing turboprop engines, he would have to reduce drag dramatically in order to increase both speed and fuel efficiency. As a result, drag reduction became his obsession. The P180 would be radically different from any other business airplane designed up to that point.

This started with the three lifting surface configuration, which Mazzoni invented and patented. The design features a forward canard wing, main wing and horizontal tail.

The forward wing produces nose-up lift that offsets the nose-down pitching moment produced by the main wing. This has a three-fold benefit. First, it augments the lift produced by the main wing. Next, the horizontal tail can be made smaller because it doesn't have to be sized to produce enough down force to control aircraft pitch attitude at low speeds when pitching moments are the greatest. And finally, every pound of down force not generated by the horizontal tail is a pound of lift the main wing doesn't have to produce, allowing the main wing to be made smaller and thereby reducing induced drag.



Piaggio Aero has given the Avanti II a completely new interior for 2008, including LED wash lights and restyled sidewalls, along with arm rails and chairs. One configuration includes a single side-facing chair on the left side, next to the entry door, a two-place divan on the right side, a pyramid cabinet refreshment center and four chairs in an aft club group.



Looking forward from the back of the 2008 cabin, the improvement in space utilization is quite apparent. Piaggio Aero engineers also believe they'll be able to reduce empty weight by 150 to 200 pounds, potentially increasing the tanks-full payload by one passenger.

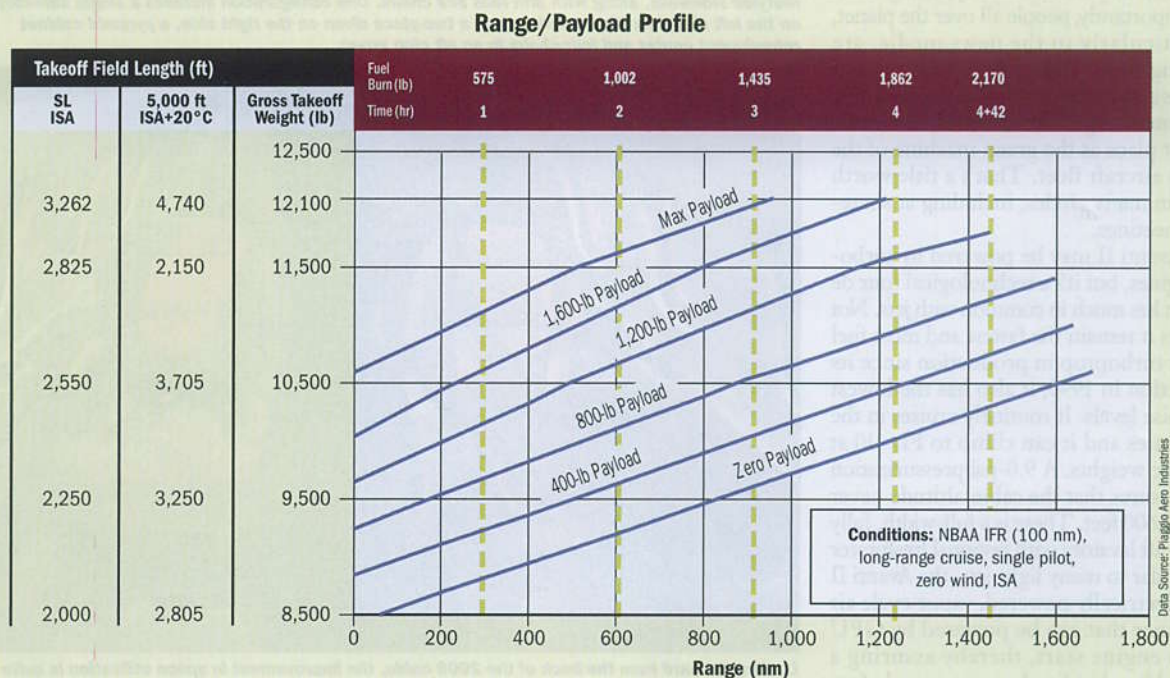
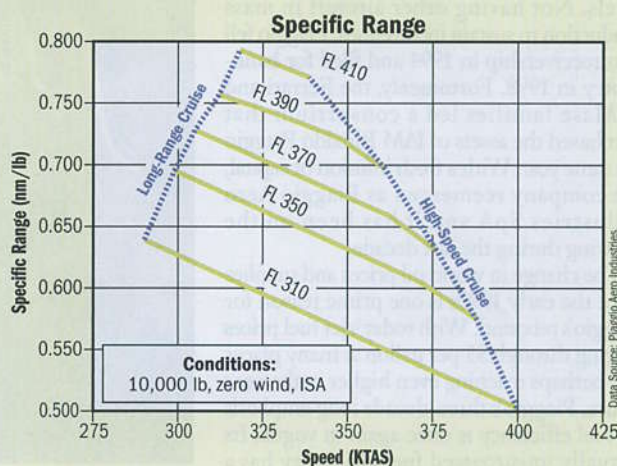
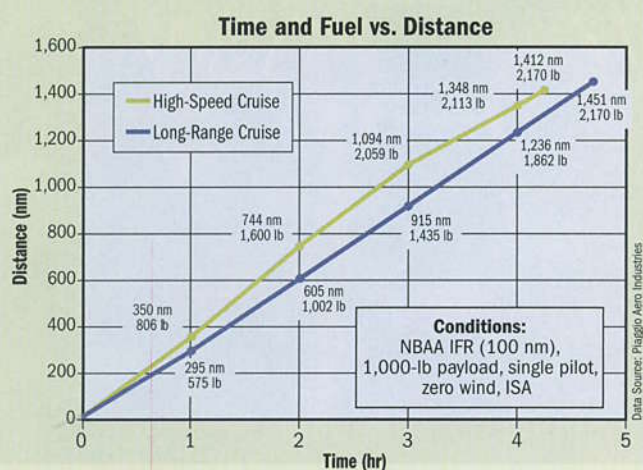
Piaggio Avanti II

These three graphs are designed to provide a broad sketch of the Avanti II's performance, based upon estimates from Piaggio Aero Industries' engineering team. Do not use these data for flight planning. Such data will be available for operators from Piaggio when the 2008 Avanti II enters service in North America.

Time and Fuel vs. Distance — This graph shows the performance of the Avanti II at maximum cruise speed (yellow line) and long-range cruise speed (blue line). The data were obtained, interpolated or extrapolated from Piaggio's Avanti Flight Planning Guide Revision 4.0, April 2007. The numbers at the hour lines indicate the miles flown and the fuel burned for each of the two cruise profiles.

Specific Range — This graph shows the relationship between cruise speed and fuel consumption at representative cruise altitudes for a 10,000-pound, mid-weight Avanti II. The data were interpolated from Piaggio's Avanti Flight Planning Guide Revision 4.0, April 2007.

Range/Payload Profile — The purpose of this graph is to provide simulations of various trips under a variety of payload and two airport density altitude conditions, with the goal of flying the longest distance at long-range cruise. Assume a 7,800-pound spec BOW. Each of the six payload/range lines is plotted from multiple data points, ending at the maximum range for each payload condition. Only the end points reflect the actual performance of the aircraft. The mid-points were estimated by B&CA. Data were obtained from the Avanti II AFM and Flight Planning Guide Revision 4.0, April 2007. The time and fuel burn dashed lines are based upon the long-range cruise profile shown in the Time and Fuel vs. Distance graph. The all-engine runway distances over a 50-foot obstacle assume takeoff/approach flaps configuration.



Therefore, the Avanti has a relatively small, low-drag main wing. Wing loading is 70.2 pounds/square foot, which is similar to that of a super light or midsize jet. This results in a smoother ride in rough air. But the modern laminar flow airfoil provides excellent high-speed buffet margins, peaking at 0.60 Mach. At 11,500 pounds and FL 390, for instance, the aircraft is buffet free up to a 54-degree angle of bank.

Mazzoni knew that using a forward canard for primary pitch control tends to destabilize the aircraft, as the Wright brothers discovered more than a century ago. Therefore, he retained a conventional aft horizontal stabilizer and trailing edge elevator for primary pitch control. The forward wing is fixed in position on the nose. Its trailing edge flaps mainly are used to produce additional lift at slow speeds to offset the increased nose-down pitching moments associated with extending the main wing flaps. Notably, the forward wing has a slightly higher angle of incidence than the main wing, causing it to stall just before the main wing reaches its maximum lift coefficient. In addition, the aircraft has twin ventral stabilizing fins that help impart a nose-down pitching moment and also help prevent yawing moments at high angles of attack. The result is the most docile stall characteristics of any current production business turboprop, in *B&CA's* opinion.

The constantly changing cross section of the fuselage also contributes about 20 percent to the total lift. Similar to the wing, the fuselage is designed to promote laminar flow. Fuselage lift helps reduce the size of the main wing. The downside is that while the Avanti has a Learjet 60-size main cabin cross-section, it has a Learjet 24-size cockpit.

Mazzoni worked with Dr. Gerald Gregorek of Ohio State University to design a clean-sheet, laminar flow wing. (See "A Word From the Doctor" sidebar.)

Preserving laminar flow over both the fuselage and wings requires maintaining very tight manufacturing tolerances for all outside contours. Piaggio pioneered an innovative outside-inside assembly process for the fuselage, similar to processes used for composite aircraft construction. Its complex-curve, stretch-formed and chemically milled aluminum skins are placed in vacuum molds to assure the loft lines conform to precise aerodynamic design standards. Then, the internal substructure of ribs and stringers is attached to the insides of the skins using mechanical fasteners.

Piaggio fabricates almost all the primary airframe structure in-house from aluminum alloys. The firm decided long ago that the carbon-fiber composite empennage, nose and forward wing of the original aircraft, manufactured by Sikorsky in the United States,



The distinctive front wing is an essential component of Alessandro Mazzoni's three lifting surface configuration that reduces the workload of the aft horizontal stabilizer, thereby slashing drag.

saved very little weight and drove up manufacturing costs. However, the horizontal stabilizer still is fabricated from carbon fiber.

The engine nacelles also are made from carbon fiber because they have very complex wasp-waist shapes dictated by transonic area-rule aerodynamics.

The main wing skins are milled out of two-

inch-thick aluminum slabs, so they incorporate integral stringers and stiffeners. After milling, the wing skins are shot-peened in molds to achieve the design aerodynamic contours. The upper and lower wing skins then are riveted onto a ladder structure composed of machined forward and aft spars reinforced by chord-wise ribs. Leading and

Piaggio Avanti II

B&CA Equipped Price\$6,475,000

Characteristics

Seating1+7/9
Wing Loading61.8
Power Loading7.12
Noise (EPNdB)76.0

Dimensions (ft./m)

External
Length47.3/14.4
Height13.0/4.0
Span46.0/14.0
Internal
Length14.1/4.3
Height5.8/1.8
Width (Maximum)6.1/1.9
Width (Floor)4.3/1.3

Power

Engine2 PWC PT6A-66B
Thrust (shp ea.)850
Flat RatingISA+45°C
TBO (hr)3,600

Weights (lb/kg)

Max Ramp12,150/5,511
Max Takeoff12,100/5,489

Max Landing11,500/5,216
Zero Fuel9,800c/4,445c
BOW7,800/3,538
Max Payload2,000/907
Useful Load4,350/1,973
Executive Payload1,400/635
Max Fuel2,802/1,271
Payload With Max Fuel1,548/702
Fuel With Max Payload2,350/1,066
Fuel With Exec. Payload2,802/1,271

Limits

Mmo0.700
Vmo260
PSI9.0

Climb

Time to FL 37024 min.

Cellings (ft/m)

Certificated41,000/12,497
All-Engine Service41,000/12,497
OEI Service24,700/7,529
Sea Level Cabin24,000/7,315

CertificationFAR Part 23,
1990/2006/2007 pending

trailing sections complete the wing. "Stout" would be an apt descriptive term for the wing structure.

The fuselage is divided into three groups: the forward section, aft fuselage and tail cone. The nose of the forward section houses most of the avionics and front wing spar carry-through structure. The aft fuselage assembly, including the aft pressure bulkhead, carries most of the loads. The main wing spar attaches to the aft pressure bulkhead, along with the forward landing gear pivots. The aft fuselage also carries the loads of the fuselage fuel tanks, systems components and aft baggage compartment. The tail cone carries

the loads of the T-tail empennage.

About 16,000 assembly hours are required to build the P180 in Genoa. This does not include the labor hours required to build most of the sub-components at Piaggio's heavy manufacturing plant at Albenga, about 60 miles southwest of Genoa. Early production aircraft were much more labor intensive. Piaggio's old world Ligurian craftsmen spent hundreds more hours slathering the airframe in body putty and then hand sanding its surfaces to near perfection. Many industry observers looked at the aircraft and assumed it was all composite instead of aluminum because of its Maranello-like finish work.

Rockwell Collins Pro Line 21 Avionics

The Avanti II's front office is equipped with a full complement of Rockwell Collins avionics, featuring three, eight-by-10-inch, portrait configuration adaptive flight displays, a glareshield flight guidance control panel, a console-mounted FMS 3000 CDU with radio tuning function and a panel-mounted radio tuning unit. The MFD has an engine instrument display feature, but no crew alerting function or systems schematics. The Avanti II retains the original aircraft's 28 annunciator light panel.

Most of the remote-mount gear, including the dual integrated avionics processors, Pro Line 21 radios, dual AHRS, dual digital air data computers and solid-state Doppler turbulence detection weather radar, is located in the nose avionics bay.

Standard equipment includes a single Rockwell Collins ALT-4000 radio altimeter, dual VOR/ILS/marker beacon receivers, dual VHF COMM transceivers, left- and right-side audio control panels, single triple-channel DME and ADF, a Mode S diversity transponder with extended squitter (long word) function for European operations, a single GPS-4000A receiver without WAAS capability, dual flight guidance computers and single three-axis autopilot. Also included are an AirCell Iridium satellite phone, L-3 Sky Watch HP TCAS I, L-3 Landmark TAWS and an L-3 integrated standby instrument system with its own emergency battery pack.

Options include an IFIS 500i file server that's required to host the optional electronic charts package, enhanced map graphics and XM satellite radio weather functions. The single file server configuration won't qualify for Class III EFB paperless cockpit operations, so you'll need a second, stand-alone EFB notebook if you want to leave your approach plates in the home office. Collins TCAS II is available as an option, along with an L-3 Stormscope lightning sensor and Honeywell KHF 990 HF transceiver. Buyers also may opt for just the HF radio wiring provisions.



Current production models have excellent fit and finish, but Piaggio no longer fills in every joint and rivet head with body filler. The change doubtlessly reduces empty weight and it makes the aircraft much easier to strip and refinish when it's time to repaint. Piaggio also plans to build a new technology heavy manufacturing plant at Finale Ligure to increase staff productivity and it's ramping up production in Genoa with the same number of employees, resulting in reduced labor content.

The Avanti II's systems in part reflect Piaggio's old partnership with Gates Learjet. Many are complex by current standards, especially for a turboprop. Primary flight controls are mechanically actuated, but the aircraft has a trimmable horizontal stabilizer actuated by primary and secondary electrically powered jack screws. Tabs on the right aileron and rudder provide roll and yaw trim.

Three pairs of electronically controlled and electrically actuated trailing edge wing flaps provide high lift at low speeds. The outboard main wing Fowler flaps, forward wing flaps and inboard main wing flaps move sequentially to minimize pitching moments caused by flap extension or retraction. But extension and retraction are relatively slow processes. It takes 16 seconds to move the flaps between clean and takeoff/approach mid-position. It takes another five seconds to move the flaps between mid and landing. The downside of the sequenced flaps is having to wait 16 seconds to clean up the airplane in the event of an engine failure just after liftoff on takeoff.

The 2,802-pound capacity fuel system has four tanks on each side, a fuselage fuel cell atop the wing, a wet wing and two collector tanks in each main landing gear wheel well. Fuselage and wing tank fuel is transferred to the collector tanks by gravity. All tanks vent to the fuselage tank, which is the only tank that is vented to the atmosphere. The aircraft may be refueled by means of a single point pressure refueling receptacle just behind the right wing or a refueling port on top of the fuselage. An anti-icing additive is required and temporary use of avgas is prohibited. Third-party line service personnel said the aircraft can be refueled in nine to 10 minutes with completely empty tanks.

Fuel quantity is displayed on the MFD. The maximum fuel imbalance is 200 pounds. The Avanti doesn't use jet pumps to feed the engines. Instead, it has electrically powered main and standby fuel boost pumps in the collector tanks. The fuel system has a cross-feed function, but it requires the cross-side fuel boost pump to be turned off to create differential fuel pressure. Indeed, all boost pump functions are manually selected.

An electrically powered, dual-mode hydraulic power pack system provides power to actuate the landing gear, wheel brakes and nosewheel steering. The reservoir is pres-

surized with engine bleed air to prevent foaming. Putting the landing gear handle up or down causes the pump to operate in the high mode, generating 1,800 to 3,000 psi hydraulic pressure to actuate the landing gear. When the landing gear are retracted, the pump shuts off. When the landing gear are down and locked, the hydraulic system shifts to the low mode, providing 800 to 1,200 psi pressure to actuate the nosewheel steering and wheel brakes. Similar to early Learjets, the Avanti has a dual-authority nosewheel steering system, with high gain for taxi and limited gain for runway operations.

In the event of power pack failure or system leak, enough fluid remains in the hydraulic reservoir to allow the landing gear to be extended by means of a manually operated pump. The wheel brakes continue to function, but with heavy pedal pressure required to stop the aircraft at high speeds. The nosewheel steering system is inoperative, requiring differential power and braking to steer the aircraft.

The main landing gear have single wheels and the nose gear has dual wheels, with geometry similar to that of a Mitsubishi MU-2. The main landing gear have pronounced positive camber when unloaded and that changes to slight negative camber with weight on wheels. Avanti pilots told *B&CA* to budget for tire changes at 200 landings.

The main wheels have carbon disk brakes that are powerful but lack an anti-skid function. Be careful when applying the brakes on a contaminated runway.

The nosewheel steering is controlled by means of the rudder pedals. When not needed for nosewheel steering, the steering actuator acts as a shimmy damper.

The 28-VDC, parallel bus electrical system has a standard 25.2 volt, 38 amp/hour nicad or optional 24-volt lead-acid battery located in the front of the aft external baggage compartment. There is a separate five amp/hour battery behind the instrument panel to power emergency equipment, including the integrated standby instrument system and VHF comm 1 radio operating on 121.5 MHz.

Two 28-VDC, 400-amp starter generators power individual generator buses. Virtually all normal starter/generator functions are automatic. A separate battery bus is fed by the battery or external power. The three buses feed various main, essential and nonessential, and avionics sub-buses, using a distribution architecture similar to that of a modern transport-category airplane.

The Avanti II is equipped with a recognition light mounted in the leading edge of the vertical tail, plus retractable landing/taxi lights in the nose that may be used at speeds below 160 KIAS. Incandescent bulbs are used for all external lights, including the landing/taxi lights, except for the anti-collision strobes. Piaggio is exploring the possibility of



Single-point pressure refueling allows the aircraft to be topped off in no more than nine to 10 minutes.

upgrading to long-life LED and HID lights.

The 9.0-psi pressurization system is controlled primarily by a fully automatic electro-pneumatic pressure controller, backed up by a manually adjusted, pneumatic controller. Primary and secondary outflow valves in the aft pressure bulkhead modulate the pressurization. Maximum cabin altitude is 6,600 feet at FL 410. An emergency pressurization system ports engine bleed air directly into the cabin through a check valve in the aft pressure bulkhead. A 40-cubic-foot supplemental oxygen bottle supplies both the cockpit masks and passenger masks that automatically deploy if cabin altitude exceeds 14,000 feet.

Engine bleed air is used for heating. With both generators operating or with a GPU plugged into the aircraft, a high-capacity vapor-cycle air conditioner, with separate evaporators for the cockpit and cabin, provides cooling. Maximum operating altitude is 20,000 feet. Above that altitude, a bleed-air heat

exchanger chills the air for cabin cooling. The system features dual zone temperature control, but only the crew can adjust cockpit and cabin temperatures.

A vibrating ice detection probe triggers a cockpit warning of ice accretion. Bleed air is used for wing leading edge anti-ice protection and electric heating elements prevent ice from forming on the forward wing leading edge. The vertical fin and horizontal tail do not have ice protection. Deicer boots on the nacelle inlets and inertia separators in the inlet ducts protect the engines. Electrical heaters keep the windshields, probes and static ports free of ice buildup. Engine fire protection is provided by fire/overheat detection loops and individual halon fire extinguishing bottles.

Qualitative Flying Impressions

We flew s.n. 1139 for this report, the first Avanti II delivered to a European customer, for an evaluation flight in a tightly bounded



The Avanti II's new P&WC PT6A-66B turboprop engines shave 24 percent off the time to climb to FL 390. Quicker climb times also use less fuel, thereby increasing range.



A remote sensor panel enables the pilot to check engine oil levels, plus hydraulic fluid quantity and filter. The "TANK INTCOM" annunciator illuminates during single-point pressure refueling to indicate that both sides of the fuel system are receiving fuel.

Military Operating Area above the Mediterranean Sea just south of Genoa. Aircraft operating limitations, ATC climb restrictions and the diminutive size of the test area prevented us from recording precise quantitative climb and cruise performance data.

We were accompanied by Lorenzo Villi, a senior test pilot for Piaggio Aero Industries, and Enrico Sgarbi, head of media relations for the firm. The warm and humid weather was typical for Liguria in summer. Villi summoned a group power cart and turned on the electrically powered vapor-cycle air-conditioning system while we walked around the airplane during the preflight inspection.

Villi pointed out some of the aircraft's workload easing features, including its remote engine oil and hydraulic fluid quantity indicating system and the single-point pressure refueling capability. We noted, though, that battery access through a forward panel in the aft external baggage compartment is

somewhat difficult for pilots less than six feet tall.

Upon boarding the aircraft, we found the cabin comfortably cool, having benefited from 15 minutes of air-conditioning. Villi activated a stored flight plan in the FMS 3000 that enabled the MFD to show the boundaries of the MOA in which we would soon operate.

The single-pilot BOW of s.n. 1139 was 8,143 pounds. With Villi and Sgarbi, we computed the zero fuel weight at 8,543 pounds. Loaded with 2,600 pounds of fuel, the ramp weight was 11,143 pounds. We plotted the AFM takeoff graph with adjustments for the 11,000-pound takeoff weight, flaps mid-position, a sea level pressure altitude and 29°C outside air temperature and computed an all-engine takeoff distance of 3,500 feet over a 50-foot obstacle.

Plotting the graphs is inconsistent at best. Tabular data would be much easier to use and

it would produce more uniform results, in our opinion. The AFM chart also recommended a 104 KIAS rotation speed to achieve 120 KIAS at 50 feet and 140 KIAS OEI climb speed for all weights. Normal climb speed is 160 KIAS.

The Avanti II, being an FAR Part 23 aircraft, isn't required to have OEI takeoff and climb performance charts. However, the AFM has a positive rate of climb weight/altitude/temperature chart, OEI takeoff distance to 50 feet with landing gear down and flaps extended to the mid-position, and OEI climb rate and gradient charts with gear and flaps retracted for the original P180 Avanti. For our takeoff conditions, the published OEI climb gradient with gear and flaps retracted was 4.5 percent.

Updated performance charts reflecting the Pratt & Whitney Canada PT6A-66B's peppier performance have yet to be published for Part 23 aircraft. Temporary changes for EASA-approved aircraft are available. But even those charts won't include complete OEI takeoff and climb performance data computed using Part 25 or Part 23 commuter category methods.

The aircraft is an excellent candidate for a handheld runway and climb performance computer. Alternatively, it would be ideal if such performance computations could be hosted by the FMS 3000, as they are in other aircraft.

We ran through a standard series of systems checks, using the rotary test switch. To start the engines, we switched on the main boost pump in each fuel tank and flipped on the start switch. At 13 percent N2 gas turbine rpm, we advanced the combined condition/prop lever to ground idle. This introduces fuel and activates the ignition system, plus it moves the prop from feather to ground idle. With the availability of ground power, the peak ITT during start was well below the 1,000°C start limit. The starters automatically disengaged at about 40 percent N2. After the GPU was disconnected, we turned on the generators, switched on the hydraulic power pack and flipped on the switches for oil cooler cross-flow cooling.

The aircraft has plenty of residual thrust at idle, so very little power is needed to begin taxiing. After we were rolling, we used some beta pitch and a little reverse to help control taxi speed. Villi also recommended lightly riding the brakes to warm up the carbon disks.

The nosewheel steering in the high-gain taxi mode is a little sensitive, not unlike that of early 20 and 30 series Learjets. In the low-gain takeoff mode, however, there is a +/- six degree dead band in the center of rudder pedal travel to provide better crosswind control.

Soon, we saw the capabilities of the Avanti II's new Pro Line 21 system with optional file server and electronic charts. Villi called up the



The Avanti II's 400-plus-knot maximum cruise speed is achieved at 2,000 rpm. Prop noise inside the aircraft is subdued, but still noticeable. Pull back the props below 1,900 rpm and it's so quiet inside the cabin that you'll think you're aboard a modern jet.

airport diagram on the MFD, enabling us to view our position on the general aviation ramp and plot our taxi route. It was easy to follow ground control's instructions to taxi to Runway 29 via Taxiways N, M, P and F, even though this was our first flight out of Genoa Sestri Airport.

While holding short of the runway, Villi advanced the prop levers to flight idle, increased power to achieve 2,000 rpm and checked the autofeather and prop over-speed governor functions. Both checks are critical and they must be done once per day, but they're best performed with passengers not on the airplane because they tend to jolt the cabin.

Turning onto Runway 29 at Taxiway F, we had 6,800 feet of pavement remaining. This was plenty for OEI accelerate-stop or accelerate-go over a 50-foot obstacle, if one engine had failed at rotation. The AFM, though, recommends aborting the takeoff at or after rotation, "if sufficient runway remains for a safe stop."

We set takeoff power on the roll, asking Villi to fine-tune torque to 100 percent. Stick force at rotation was comparatively heavy for this class of aircraft, but it's to be expected considering the short distance between the elevator and the center of gravity with the aft-mounted pusher prop engines.

We retracted the landing gear with a positive rate of climb, then the flaps at 135 KIAS and settled into a 160 KIAS climb. The prop levers are left at 2,000 rpm for the climb, resulting in noticeable prop noise in the cockpit. It was quieter in the main cabin, according to Sgarbi.

Pitch control forces remained relatively heavy, but the stab trim system has a nice balance between effectiveness and sensitivity, so it's quick and comfortable to trim the aircraft to eliminate control wheel pressures. We also noted that the aircraft exhibits exceptionally strong short period pitch, roll and yaw damping. Without using the yaw damper, the aircraft dampens full rudder pedal deflection inputs in less than two cycles. Later in the flight, we checked long period pitch damping at 195 KIAS and FL 360. We pulled up the nose to dissipate 10 percent of the airspeed and let go of the wheel. The aircraft had a 78 second phugoid and strong positive pitch damping.

At FL 380, we attempted a maximum cruise speed check. But the short legs required to stay in the MOA prevented us from maintaining stable flight for more than three minutes at a time. At a weight of 10,500 pounds and in ISA+5°C conditions, we achieved a cruise speed of 350 KTAS, about six knots slower than book predictions.

We also checked Mach buffet boundaries at FL 380. The aircraft was buffet free between 0.60 and 0.61 Mach at up to 60 degrees angle of bank.

Prop noise was still quite evident at 2,000 rpm at FL 380. But as soon as we pulled back the props below 1,900 rpm, the Avanti II's interior sound levels became virtually indistinguishable from those of most current production light jets. At 1,800 rpm, interior noise levels do not exceed 65 dB speed interference level at FL 230 and 350 KTAS, according to Piaggio. We believe sound levels at FL 380 are lower.

Down at FL 310 and still in ISA+5°C conditions, the aircraft cruised at 380 KTAS at full power and 2,000 rpm, about six knots slower than book. We chalked up both anomalies as by-products of flight test limitations. Villi said that all production aircraft he's flown make book cruise speeds, assuming long test legs.

It's quite apparent that the Avanti II's vaunted 400-plus-knot cruise speeds come at the price of prominent prop noise, albeit lower than in any other current production business turboprop. We again reduced rpm

to about 1,900 to check interior sound levels. With 100 less rpm, you'll lose five to 10 knots of cruise speed. You'll also transform this very quiet turboprop into a near silent jet for the folks in the main cabin.

Descending to 15,000 feet for air work, we flew a complete series of full stalls. The Avanti II's high angle of attack behavior is exemplary. Its handling manners are virtually unequalled by any turboprop aircraft we've yet flown. During each maneuver, stalls were preceded by the aural stall warning along with generous buffet. With full aft yoke deflection, the nose drop was gentle and there was no tendency for wing roll-off, except for an unexpected slight left wing drop during the landing configuration stall caused by asymmetric prop governor settings. Villi recorded that snag for postflight maintenance follow-up.

Then we headed for Genoa Sestri for an ILS Runway 29 instrument approach. Villi called up the ILS DME-P Runway 29

Pratt & Whitney Canada PT6A-66B Turboprop Engines

The Avanti II's "new" 850-shp Pratt & Whitney Canada PT6A-66B engines have higher temperature margins and 8 to 13 percent more high-altitude power output than the -66 engines they replace. They are able to produce takeoff power to ISA+49°C, a 7°C improvement over the predecessor engines that powered the Avanti I.

This wasn't accomplished by means of some technological breakthrough. P&WC is a master of parts bin engineering when it comes to its PT6A line, a powerplant family that dates back to the mid-1960s. To create the -66B, P&WC essentially transplanted the gas generator core of the -67A engine into the -66 housing. The -66 and -67A engines both earned their type certificates in 1987.



Both the -66 and -66B share the same basic pusher prop architecture. Intake air flows through a four-stage axial/single-stage centrifugal compressor. Fuel is injected in the annular, reverse flow combustor. A single-stage turbine powers the compressor. Then, exhaust gases flow through a two-stage power turbine connected to the reduction gearbox. A five-blade Hartzell propeller, with supercritical airfoil aerodynamics designed

by Dr. John Lee of Ohio State University, converts power into thrust.

Like all PT6A engines, the -66B requires plenty of attention to set takeoff/go-around power, to prevent exceeding torque and temperature limits, to adjust engine output in response to density altitude changes on climb-out and when the particle separator doors are opened or closed. Toss in the pre-takeoff auto-feather and prop over-speed checks and the result is a high pilot workload powerplant by today's standards.

The pusher configuration also means that supplemental ambient air cross-flow may be needed for the oil coolers because their intakes aren't fanned by the props. Avanti has bleed air-powered jet pumps that provide this function, but the pilot has to remember to activate the supplemental cooling function when needed on the ground and then deactivate the system when it's no longer required.

The Avanti II deserves better. For all the PT6A's admirable durability, a 21st century turboprop aircraft, particularly a model approved for single-pilot operation, should have FADECs and single power-lever controls. All the related care-and-feeding functions should be automated, just as they are in today's turbofan airplanes.



Trailing edge flaps on the forward wing increase nose lift to compensate for the nose-down pitching moment caused by extending the main wing flaps. Piaggio Aero doesn't call the forward wing a canard because it lacks primary control surfaces. Pitch control is accomplished by means of the trimmable horizontal stabilizer and elevator at the rear of the aircraft.

A Word From the Doctor

Dr. Gerald Gregorek

The Avanti was one of the highlights of my career. The laminar flow airfoils were very clean sheet. I think they were the first of the new breed of laminar flow airfoils that demonstrated high performance at transonic speeds.



Dr. Gerald Gregorek

I was director of a NASA-supported General Aviation Airfoil Design and Analysis Center and I had access to new computation codes to develop advanced airfoils for the general aviation community. Professor Jan Roskam put Dr. Alessandro Mazzoni, then Piaggio's chief engineer, in touch with me to design airfoils for the Avanti. This was in the summer of 1980. Before I could accept this job, I had to clear this design task with NASA headquarters, since the Avanti was Italian and there was a restriction on some of this technology. NASA said OK, but to keep the methodology secure. Also, the GA companies had rejected earlier laminar flow designs, believing them to be impractical, and this was a chance to put the new technology into practice.

We designed the airfoils to have 45 percent laminar flow on the upper surface and 55 percent on the lower surface. At that time I felt that was a conservative approach that was doable. Its design lift coefficient was $Cl = 0.45$, the desired value for the high-altitude cruise speed. Since the design Mach number was 0.67, compressibility and transonic flow had to be considered as well. Airfoil thickness was just under 15 percent. The canard is of similar profile, but thinner.

After we had designed the airfoils, Piaggio asked us to design the high lift system as well. We did this, again using our computational tools, and the Fowler flaps on the wings and the slotted flaps on the canard were developed.

You may be interested in the Piaggio propeller. Hartzell fabricates the five-blade pusher, but the aerodynamics were developed in our Laboratory by Dr. John Lee. Hartzell provided us with the necessary thickness-to-chord ratio so that the prop would have sufficient strength, but the airfoils that produced the thrust were all brand new. Not to be laminar, but to control the supercritical flow over the blade. When you are at $M = 0.67$ shocks can occur on portions of the blade even before you start to rotate the prop and reach near $M = 0.95$ at the tip. Dr. Lee developed a family of thin airfoils to be used on the blades, and determined the proper twist distribution for Hartzell. You may want to look at the prop to see the different trailing edges, for example.

approach chart on the MFD, enabling us to review the procedures, including the 19 DME arc entry leg. The FMS 3000 is fully capable of flying such approaches hands-off, but this particular arcing procedure isn't in the Jeppesen database, so we flew it manually.

However, activating the approach in the FMS pre-tuned the NAV 1 radio to the localizer frequency and automatically preset the 287-degree inbound course on the PFD. We pulled back the props to 1,800 rpm to assure minimum noise impact turning over Portofino to the final approach course for the benefit of all the Benetti owners anchored in the cove. We've noticed several times from the ground that the Avanti II's noise footprint is quite prominent at 2,000 rpm.

The aircraft is very stable on approach. Flap and gear extension/retraction produces very small pitch moments. But the aircraft does exhibit some thrust/pitch coupling because the engines on the mid-mounted wing are above the center of gravity. We used 120 KIAS for an approach speed, but the AFM recommends 117 KIAS at landing weights of 10,270 pounds or below. Our landing weight was 10,100 pounds. The computed landing distance was 2,500 feet over a 50-foot obstacle, assuming no prop reverse and dry pavement conditions. With prop reverse, the distance drops 10 percent on a dry surface or more if the runway surface is contaminated.

In preparation for landing, it's essential to keep in mind that the Avanti II sits low to the ground. We flared too high and that prolonged the touchdown. The Avanti's very long travel main landing gear soaked up the imperfections in technique. Villi reset the flaps to the mid-position and adjusted pitch trim to the takeoff position. We added power, rotated and climbed to VFR traffic pattern altitude on the downwind leg.

After our second landing, Villi reduced power on the right engine to approximate zero thrust, as though the engine had failed and autofeather had been activated. Rudder pedal force was considerable because of the relatively short moment arm between the rudder and center of gravity. After rotation and with a positive rate of climb, we retracted the landing gear. We climbed at 120 KIAS to 400 feet, accelerated to 140 KIAS and retracted the flaps. Rudder pedal forces were reduced, but still considerable compared to current production turboprop and turbofan business aircraft.

We flew the third circuit with the simulated engine failure and made the final approach at flaps mid-position, 135 KIAS. We slowed to 125 KIAS near the runway surface, touched down and decelerated to taxi speed by midfield.

Conclusions? The Avanti II certainly blurs the boundaries between turboprop and turbofan aircraft with its speed, quiet cabin and unmatched fuel efficiency. But it's not a low workload aircraft for pilots because of

systems complexity and 1960s-vintage hydro-mechanical engine fuel controls that are shared by virtually all other PT6A-powered aircraft. The AFM also needs updating with complete OEI takeoff and climb charts. The data would be much easier to use if they were presented in tabular format.

Price and Value

The Avanti II indeed is the most expensive turboprop in *B&CA's* May 2007 *Purchase Planning Handbook*, but it's also the fastest. For the Comparison Profile, we chose to include the two turboprops and the two turbofan business aircraft with price tags closest to that of the P180. Coincidentally, all five aircraft are equipped with Rockwell Collins Pro Line 21 avionics, so they share similar cockpit capabilities, including optional electronic charts, enhanced map graphics and XM satellite radio weather.

The Comparison Profile illustrates that the Avanti II splits the difference between turboprop and turbofan aircraft. It fares quite well in the composite average of the five aircraft, with the exception of cabin length. The right section of the graph shows that the P180 is the runaway winner in fuel efficiency.

The Avanti II's climb performance above FL 370 is significantly improved because of the higher flat-rating of its -66B engines. Assuming standard day conditions, the second-generation airplane can climb directly to FL 400, resulting in better fuel economy and slightly longer range performance. The new engines also enable the aircraft to join the coveted 400-knot cruise club, but only down at FL 310.

We caution our readers to note that the takeoff field distances for the Beech King Air 350, Beech Premier IA and Cessna Citation CJ3 all are based upon one-engine-inop-

erative conditions at V1. Takeoff distances for the Avanti II and Beech King Air 200 assume all engines operating.

For 2008, the Avanti II gets a new interior designed by Infusion Design of Bonner Springs, Kan. Details of the interior are slated to be released at this month's NBAA Convention in Atlanta. The new interior should shave empty weight by 150 to 200 pounds, enabling operators to carry eight passengers with full fuel.

Fuel efficiency is going to become a more visible issue for business aircraft operators. And the Avanti II is the most eco-friendly twin-turbine business aircraft in production. But you don't have to fly at typical turboprop speeds to get great fuel economy. It's not as fast as most jets, but it surely scores high points with passengers, CFOs and environmentalists. That's a pretty good start for a 21st century business airplane. **B&CA**

Comparison Profile
(Percent Relative to Average)



Tradeoffs are a reality of aircraft design, although engineers attempt to optimize the blend of capabilities, performance and passenger comfort.

B&CA compares the subject aircraft, in this case the Avanti II, to the composite characteristics of others in its class, computing the percentage differences for various parameters in order to portray the aircraft's relative strengths and weaknesses. We also include the absolute value of each parameter, along with the relative ranking, for the subject aircraft within the composite group.

This Comparison Profile compares the Avanti II to a composite group composed of the two turboprops and two light jets that are most closely priced to it. The four others are the Beech King Air 200, King Air 350 and Premier IA, and the Cessna Citation CJ3. The Comparison Profile shows that the Avanti II's strengths are cabin cross-section, fuel efficiency, maximum payload and IFR range. Compared to the composite average, the Avanti II's speed and cruise altitude are competitive but not exceptional.