A Binter Canarias ATR72-500 taking off in Lanzarote

ATR 42-500 and 72-500

PERFECT GO- AROUND

Threatened with extinction by the global turboprop crisis only a few years ago, ATR - the European joint venture between EADS and Alenia Aeronautica, part of the Italian Finmeccanica group - is now the world's leading manufacturer of turboprop regional airliners. Planet AeroSpace went to visit the company in Toulouse.

When Filippo Bagnato took over the helm of ATR to steer the company out of its perilous blind flight through the fog, the prestigious European aircraft-builder had only ten aircraft on its order books. Despite the good reputation of its products, ATR was at that time within inches of a sudden crash landing. The crisis was so acute that plans were already afoot to close down the final assembly line in Toulouse. Well-known manufacturers such as Saab ('340', '2000') and Dornier ('328') had already ceased to produce regional aircraft, yet the situation was still dire for the largest two remaining manufacturers in the market for turboprop regional aircraft, ATR and Bombardier.

The newly appointed CEO of the joint venture between EADS and Finmeccanica – who had previously been head of Eurofighter – could not know with certainty whether his 'touch-and-go' manoeuvre was going to succeed. More aptly than through this aviation image, the situation on the turboprop market in those days can be summed up by an analogy with sailing: it was in the doldrums.

Now, in 2006, ATR has changed beyond all recognition. With over 130 aircraft on its order-books, the company has enough work to keep it busy for years to come. It holds a record 65 percent market share in the turboprop airliner business and is pressing ahead with a consistent, if cautious, enhancement of the ATR42 and 72 series. According to Bagnato, “ATR will deliver another 25 aircraft in 2006, but numbers will reach 44 in 2007 and as many as 60 in 2008.”

The market took a sudden about-turn in 2005, and this time the situation was reversed. Rapidly escalating fuel prices posed insuperable difficulties for regional jets – whose rising popularity, as recently as the mid-1990s, had been the reason why many a turboprop model was taken off the production line. Almost overnight, there was a great demand for the significantly thriftier turboprop airliners.

▶ The company plans to deliver 44 aircraft in 2007

Numerous routes were restructured, and 50-seat regional jets became almost impossible to sell. The competition in the airline skies had actually caused fares to drop in spite of the rising operating costs. Bombardier, for instance, was forced to discontinue produc-

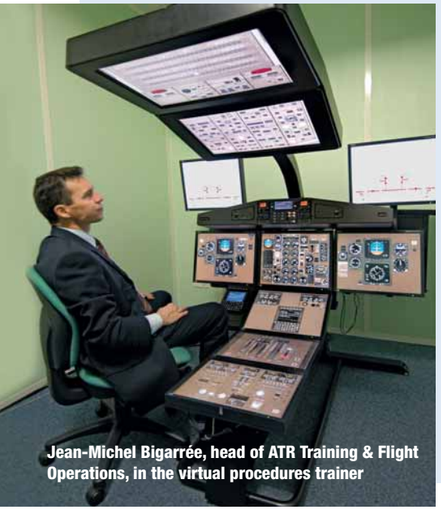
He steered the company out of a crisis: ATR CEO Filippo Bagnato

ATR SIMULATOR
ATR TRAINING ORGANISATION

ATR's new full flight trainer (FFT) creates an almost perfect illusion of flight at a significantly lower cost than a full flight simulator (FFS)

Designing, building and selling aircraft is only part of the business. Another vital element of the all-round package is supporting the customer airlines as fully as possible in their pilot training activities.

One of the chief difficulties faced by regional airlines is the fact that this class of aircraft tends to be flown by young pilots whose only experience has been gained on twin-engine training aircraft. In the ATR airliner cockpits, they are confronted with complex professional systems for the first time. Even though ATR's policy is 'simplicity' in every respect, commercial airliners are inevitably a great deal more complex, featuring additional systems such as a pressurised cabin, hydraulics and more sophisticated avionics.



Jean-Michel Bigarrée, head of ATR Training & Flight Operations, in the virtual procedures trainer

In consultation with its customers, ATR has devised an elaborate curriculum at its training centre in Toulouse (ATC). It also offers a comprehensive range of teaching aids such as the Virtual Procedures Trainer (Foto), plus various PC-based procedure trainers and flight simulators (FFS and FFT).

The latest training tool is a simulator known as the 'FFT' (Full Flight Trainer), which conveys the same realistic flying sensation at a fraction of the cost of a full flight simulator. It uses a sophisticated sight-and-sound system coupled with a seat cueing system to realistically transmit the aircraft motion and vibration to the pilot via his seat.

The FFT simulator uses these systems to generate brain motion, an unavoidable illusion which, as many pilots aver, conveys an even more realistic impression of flying than a highly elaborate Level-D-compliant full flight simulator, which is moreover many times more expensive to operate.

The author decided to put matters to the test at ATR's training centre in Toulouse, and the results were amazing. In short, I felt during all phases of the 'flight' as though I were sitting inside a full flight simulator. The ten-minute flight through heavy turbulence and thunderstorms even produced a most realistic queasy feeling in my stomach.

A further cost-saving feature of the FFT are the TFT monitors installed behind the panel lining, which simulate all the mechanical displays such as those of the engines at a much lower cost than has ever been possible before. Currently still under development, the system is expected to cost about 2.5 million euros – way below the price of an FFS.

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tion of its Canadair CRJ-200. When jets became unprofitable on short-haul routes, airlines increasingly began to operate their smaller jets on longer routes, where they in turn found themselves facing stiff competition from wider-body aircraft due to their lower level of passenger comfort and often insufficient number of seats.

On short-haul routes, however, the turboprop emerged victorious once again. The newly developed larger regional jets were in a class of their own, posing no threat at all to the turboprop market, which had settled comfortably into the 50- to 74-seat niche. "At today's fuel prices, operators of 50-seat jets would have to utilise 130 percent of their capacity to make a profit," Bagnato dryly remarks.

The ATR CEO believes that jets will be unable to pay their way unless they can offer at least 90 seats – and this is the point at which they encounter increasing competition from the smaller versions of the Airbus A320, such as the 108-seat A318, and from the Boeing 737.

The clear advantages of turboprops in terms of fuel consumption and CO_2 emission, combined with their greater versatility – on short runways, for instance – have caused the market to grow dramatically. The ATR42 and 72 use as much as 60 percent less fuel than regional jets. ATR received 90 orders in 2005 alone (and another 57 by 15 October 2006), and there is much to be said for the expectation that 'propjets', as turboprops are often called in the USA, will be able to maintain their strong position on the market. Bagnato confirms this view: "Jets will never be able to fully replace turboprops."

TURBOPROPS HAVE A CLEAR ADVANTAGE IN TERMS OF FUEL CONSUMPTION AND EMISSION LEVELS

Another key reason for the successful recovery of ATR, Bagnato believes, is the company's extremely motivated, skilled and highly qualified staff as well as its new customer support strategy.

Moreover, both the remaining turboprop regional aircraft manufacturers have learned a lesson or two in recent years and made their aircraft better equipped to compete with the jets. It was not the slightly lower cruising speed (which makes little difference on short-haul routes) that made many passengers hesitant about flying in propeller aircraft, but primarily the less comfortable environment due to the high level of noise on board.

The noise level in the cabin of an ATR42-500 or 72-500 today is roughly equivalent to that of a regional jet. ATR has achieved this through various technical gimmicks, a great deal of precision work, and meticulous quality control. The fuselage has been reinforced at several critical points,

An ATR72-500 operated by Kingfisher Airlines of India

passive vibration dampers have been built into the structure, and newer insulation material is being used. Among the most significant improvements is the six-blade fibre-composite airscrew, which replaces the former four-blade metal propeller. Its smaller diameter (which results in lower blade-tip velocity, hence less noise), the greater rigidity of the blades, more precise balancing of the propeller, and the high-precision electronic speed control and synchronisation all combine to provide an astonishingly high degree of comfort in the cabin. The pulsating interference sounds caused by poorly synchronised props is now a thing of the past.

ATR has no doubt at all that its own technological approach was the right one to take. Its design engineers are not so keen to have an active noise control system like that installed by Bombardier in its de Havilland Dash-8 'Q' series – particularly since the extra equipment (microphones, 40 loudspeakers in the cabin, controlling computer) involves additional maintenance work.

Quality control plays an important role: No ATR leaves the Saint Martin final assembly line at Toulouse airport today without having had the noise level for every single seat on board measured during its first flight - and any necessary adjustments made.

Despite all these measures, the aircraft in the ATR42/72 family have not become any more complex over the years, nor therefore any more expensive to operate.

▶ Simplicity and commonality are ATR's guiding principles

ATR moved far ahead of its rival Bombardier in 2005; its low operating costs evidently play a major role in the company's 65-percent market share. Offering cruising speeds of up to 60 knots faster than ATR, Bombardier's de Havilland Dash-8 consumes a great deal more fuel – whereas its greater speed gains it only five or ten minutes on most routes. In practical operations on average routes, such an advantage is virtually irrelevant.

The other side of the coin is that the higher speed necessitates hydraulic support for the flight control systems – which in turn results in greater weight and complexity and hence a greater need for maintenance. For ATR, on the other hand, the simplicity principle seems to pay off.

The first-generation ATR42 launched on the market in 1985 was supplemented in 1989 by an elongated '72' version featuring various technological enhancements – though only to details that do not jeopardise the aircraft family's 'commonality' principle. The ATR72's wing box, for example, is made of carbon fibre composite materials. In 1996 the manufacturer presented the '500' series for both types, which is distinguished

ATR TECHNIK
Technische Daten

ATR	42.500	72-500
Max. takeoff weight:	18.6 t	22.8 t
Maximum range*:	1560 km	1860 km
Max. cruise speed:	300 kts	276 kts
No. of seats:	48-50	68-74
Max. payload:	5750 kg	7850 kg

* at max. takeoff weight

The traditional 'St. Martin' plant in Toulouse. This is where the entire final assembly of the ATR42 and ATR72 takes place

▲ Airframe

The airframe for the ATR42 and 72 is built by Alenia at Pomigliano, close to Naples. It was significantly reinforced as part of the redesign prior to the introduction of the ATR72-500 in the mid-1990s. This reduces vibration and thus also noise, and – along with the enhanced acoustic insulation and the six-bladed propellers – is one of the factors responsible for keeping the noise level as low as that of a jet airliner. The standard configuration includes two cargo compartments, each with a capacity of five cubic metres.

Alenia in Italy has developed a 'quick change kit' with which the aircraft can be converted into a freighter in 30 minutes. A special version with an enlarged cargo door is also available.

▲ Cabin

The cabin is reminiscent of that in a jet airliner, having the widest aisle of any aircraft in its category. The interior equipment, with reading lamps and large overhead lockers, is as generous as you would find in a jet. A good view out of the aircraft is ensured by the fact that there are more windows than rows of seats. A luxury cabin with leather seats is available as an option.

▲ Propellers

The two 568F propellers (diameter 3.96m) are manufactured by Hamilton Sundstrand. They each have six blades with an electric de-icing system, are made of composite materials and feather automatically in their steel hub in the event of engine failure. The blade pitch is controlled electronically, with a hydraulic backup. Damaged propeller blades can be individually replaced on a fully installed propeller. The whole propeller only weighs 164 kilograms.

◀ Engines

The high-wing monoplane's two powerplants are the proven PW127E (2160shp, ATR42-500) and PW127F (2475shp, ATR72-500) propeller engines from Pratt & Whitney Canada, the established market leader in the manufacture of gas turbines for propeller-driven aircraft. The right engine is series-produced with a propeller brake ('hotel mode') that allows the turbine to idle before and during boarding, thus providing an autonomous power supply and air-conditioning for the cabin.

▶ Tail unit

The T-tail with its mechanically actuated elevators and rudders is made entirely of composite materials by Alenia in Foggia. The horizontal and vertical tailplane leading edges are de-iced pneumatically and the elevator horns electrically.

ATR 42/72

As complex as necessary, as simple as possible

◀ Wings

The entire wing is manufactured by EADS Sogerma in Bordeaux and delivered to Toulouse ready for assembly. All the electrical, hydraulic and mechanical components are already installed at this point, as are the two welded titanium engine mounts.

While the wing of the '42' model is made entirely of aluminium alloys (its outer wing box is built in Xian, China), the outer wing box of the '72' is made largely of carbon fibre composite material. The ailerons, each of which has a trim-tab, are mechanically actuated via control cables and rods, and their rudder control horns can be electrically de-iced. The Fowler flaps extend hydraulically into their 15-, 25- and 35-degree positions and the ground spoilers are hydraulically actuated as well.

The wing leading edges are pneumatically de-iced, as are the engine air intakes. The engine nacelles are made of carbon/Nomex sandwich material and partially reinforced with Kevlar. Composite materials account for 15 percent of the overall structure on the ATR42-500 and as much as 20 percent on the ATR72-500.

▼ Landing gear

Messier produces the ATR's hydraulically retractable tricycle landing gear. The wheels and tyres are made by Dunlop, with Michelin or optionally Goodyear providing special tyres for operation on unpaved runways. The anti-skid control system for the main landing gear is supplied by Crane Hydro-Aire.

▲ Flight deck

The avionics system of the ATR42/72 can optionally be certified for CAT II ILS precision approaches.

The navigation system is based on the Honeywell global navigation satellite sensor (GNSS). The system is linked to a modern autopilot flight director system and the electronic flight instrumentation system (EFIS). The colour weather radar can be displayed on the electronic horizontal status indicator (EHSI). Data from the enhanced ground proximity warning system (E-GPWS) are displayed on the artificial horizon. The TTR 921 traffic alert and collision avoidance system (TCAS) is manufactured by Rockwell Collins.

The ATR42-500 and 72-500 both feature an identical cockpit layout and avionics system, so that pilots of either type require only three hours' theoretical instruction to prepare them for flying the other type.

ATR FLIGHT TEST DEPARTMENT

A FLYING VISIT TO THE ATR FLIGHT TEST DEPARTMENT

ATR flight test director Eric Delesalle in the cockpit of an ATR72-500

An hour," replies Eric Delesalle, when I ask the Vice President Flight Test during my visit how long it is likely to take me, as a private pilot with multi-engine rating, to accomplish a safe takeoff and a passable landing.

I get my chance at last on the two-hour third 'acceptance flight' of an ATR72-500. Eric Delesalle makes me his 'co' without further ado, allowing me to fly the machine right through from takeoff to landing. It proves amazingly easy even for someone who has never flown a commercial airliner before. Despite its 22-metric-ton maximum takeoff weight (MTOW) - ten times as heavy as a Piper Seneca – the airliner feels almost lighter than the little piston twin as we taxi to the runway. On takeoff soon afterwards, however, the ATR quickly proves that commercial aircraft are made of sterner stuff when it comes to power and performance.

▶ Impressive flight performance

Using the switches on the panel, I adjust the two Pratt&Whitney engines to their takeoff power of 90 percent, set the flaps to 15 degrees, and off we go. Lighter training aircraft do not provide such convenience – nor, indeed, such flight performance!

Despite the airliner's heavy weight, its acceleration and pull-through are impressive. Just after reaching V1 (the speed after which takeoff should no longer be aborted), we are in the air with the runway dropping away beneath us – which of course is partly due to the fact that we are only carrying a very light load. As far as safety is concerned, a commercial airliner is far superior to any training aircraft. If either of the engines had failed during the takeoff run after reaching V1, the automatic system would instantly have feathered the propeller blades of the affected engine and increased the power of the 'healthy' engine for the takeoff phase.

It takes us only a few minutes to reach flight level 200. We are flying along the Pyrenees, while behind us in the cabin the technicians are monitoring the noise level at each individual seat. This ATR72-500 is scheduled for delivery to the customer in a week's time. At first I find it difficult to maintain a steady altitude while 'hand flying'. This can largely be put down to the efficient elevator trimming. I am unaccustomed to this, and in conjunction with the speed it causes me to trim rather too much. I also deflect the control surfaces too far at first. The Flight Director display, which can be faded-in when required, makes flying a much easier task than with only the artificial horizon.

Compared to a professional airline trainee, of course, I am flying under greatly simplified conditions. I am not required to pay attention to any of the numerous systems (Eric Delesalle does that), and the only navigation task that I have to master is to maintain an east-west course along the Pyrenees, occasionally turning onto a reciprocal course, and – for a further series of tests in the cabin – to descend to a lower flight level.

Be that as it may, my predominant impression is that the plane is much easier to fly than I had expected. Obviously, the control pressures in the 22-metric-ton ATR are much higher than in a two-ton Piper, and accurate trimming to any desired flight attitude is an absolute necessity. A beginner will appreciate finding that most of the instrumentation is similar to that of smaller aircraft and looks very familiar. This is likely to change once the Airbus-style glass cockpit is introduced, as the ATR cockpit will then look more familiar to Airbus pilots than to trainees. But it also has a positive aspect: anyone who graduates in future from the ATR to the A320 – which is the classic career pattern among many airlines that operate both types – will quickly feel at home in the ATR's larger jet cousin.

▶ An unusual appearance

As we approach Toulouse Airport, air traffic control instructs us to begin our descent, and after a few course corrections towards the airport we are cleared for an ILS approach to runway 32L. We intercept the ILS localizer at 200 knots and reach the glide slope shortly afterwards. Eric extends the flaps and the landing gear while I try to maintain the glide slope as accurately as possible. ATR's flight test director appears to trust me, for he lets me carry out the entire landing procedure on my very first flight in an ATR. It turns out less than perfect: I start the flare a bit too high up, which is mainly due to the initially unfamiliar appearance of the cockpit. Eric has throttled the power for me, and I'm glad because this enables me to concentrate fully on the touchdown. I keep the nose up until the main landing gear, further aft than I am accustomed to having it, touches down anyway after hovering for a few seconds. The cockpit is still a couple of metres up in the air at this point. Then, as I gently release the rudder, the nose wheel touches down as well – if not quite as gently as I might have wished.

Of course this brief demonstration was not a realistic flying lesson, but it certainly showed me what any young pilot wants to know before switching to a different aircraft, namely that anyone who can safely land a twin-engine trainer will not take long to master an impeccable landing with the ATR.

Needless to say, that is only the first step in professional piloting. Pilots must have a perfect command of emergency procedures and crew co-ordination, and airliner pilots must be able to operate every single one of the many systems blindfold.

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Between two acceptance flights: ATR72-500 on the apron at Toulouse airport

particularly by the low level of noise in the cabin, the six-blade propellers and new cabin furnishings.

According to ATR CEO Filippo Bagnato, engineering simplicity has been and will be a decisive factor for ATR's success. In his opinion, more modern technology can have only one purpose: to help airlines achieve their goal of saving costs. He categorically rejects any form of high technology that bears the taint of a marketing tool and involves higher operating costs. Fly-by-wire controls, or electric brakes? None of these things will find their way into the ATR unless they make the aircraft simpler rather than more complex, says Bagnato. Fewer spare parts in the depot would be a good reason for introducing 'FBW' and thereby further reducing operating costs. However, the technology is not yet sufficiently advanced.

"JETS WILL NEVER BE ABLE TO FULLY REPLACE TURBOPROPS."
Filippo Bagnato

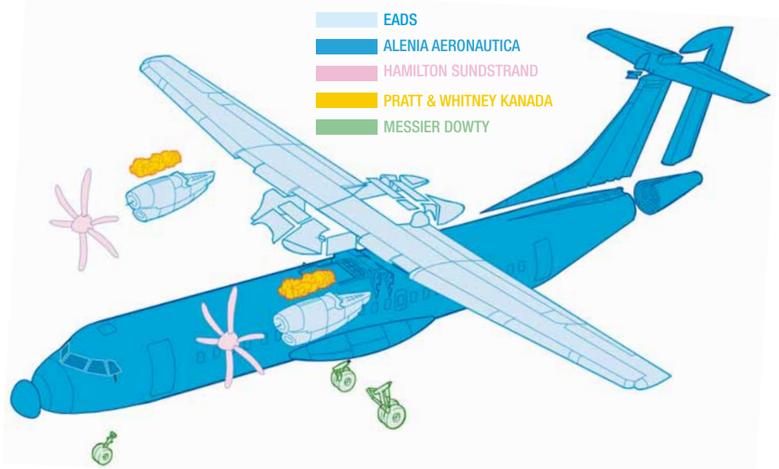
Nevertheless, ATR has invested a great deal to advance the development of its turboprops in keeping with current needs, while taking care not to dissipate its energies in a technologically complex aircraft. Bagnato explains this strategy with a metaphor from the world of sports: "You have to bear in mind which league you are playing in – and stay away from sports where you know you can't win." This is one of the reasons why there will not be an 85-seat ATR in the foreseeable future. The CEO is determined ATR remains only in the 'game' in which it ranks top of the league – regional aircraft with 50 to 74 seats. All the same, he is keeping his eyes open: "You never know, there may come a time when I consider having 85 seats."

A 'midlife update' to be carried out in the near future will not only introduce an Airbus-style glass cockpit but also enhance the aircraft's performance on short runways by using more powerful engines to enable takeoffs with a heavy payload. This improvement additionally calls for a modified rudder with greater deflection to reduce 'Vmca', the minimum speed at which a pilot can recover directional control of his aircraft, using the rudder, after one engine fails – an indispensable criterion in certifying an aircraft for takeoffs at low speed. Once it has obtained the extended certification for this modification, the ATR42/72 will be even better equipped to land on short island airstrips such as those in the Philippines or the Caribbean.

By September 2006 ATR had delivered 700 aircraft – 100 more than had been predicted for the entire life cycle of the product when it was first introduced. And having emerged from the doldrums in 2003, the company is now set to continue its success story for years to come. ATR expects to deliver its one-thousandth aircraft in about five years' time. The company's turnover in 2006 is estimated at about 730 million dollars. It expects to pass the billion-dollar mark in 2007 and anticipates revenues of 1.2 billion dollars in 2008.

Nobody in Toulouse talks about a crisis in the turboprop sector any more.

Alexis von Croy



ATR, a typical European company

Its new six-blade propeller and reduced vibration level make the ATR42/72 as quiet as a regional jet

Images: AvC, ATR, Daniel Nicholson

More ATR ... Further information on ATR aircraft, including the two freight versions (ATR Bulk Freighter and ATR Large Cargo Door conversion) and the special versions (Surveyor and Corporate), is available at www.atraircraft.com