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A SPECIAL SUPPLEMENT

Guide to financing and investing in engines 2014

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EDITOR'S LETTER

The new engine behind A330neo

After months of speculation Airbus has announced an A330neo with a sole powerplant. Dickon Harris takes a closer look at Rolls-Royce's new Trent 7000.

Airbus finally unveiled the A330neo at Farnborough in July. The European manufacturer's announcement ended continued speculation on whether it was planning an upgrade to its popular widebody.

The new aircraft was the biggest piece of news at the airshow, and Airbus has learned from its experience with the A320neo that an upgrade for popular models translates into large orders.

Air Lease Corporation (ALC) was the launch customer with a memorandum of understanding for 25 aircraft. It has since been followed by Hawaiian Airlines, Avolon and AirAsia X.

Steven Udvar-Házy, ALC's chief executive officer, predicts there will be demand for more than 1,000 A330neos between now and the end of the next decade.

"The market has evolved in two significant segments on the twin widebodies in this 250- to 350-seat category. One is the very long-range-capable airplanes, including the 787-9, the A350-900 and A350-1000 and the 777-300ER," says Hazy.

Hazy added that he expected the A330neo would "extend the family life at least another 20 to 25 years" while it served a "different segment of the market than what we had envisioned for the original A350 XWB".

The aircraft has effectively ended Airbus's A350-800 programme. The manufacturer has only 28 firm orders for the A350-800 after Hawaiian announced a switch in late July. Airbus will continue with the A350-900 but is pushing the customers which have made firm orders for the A350-800, including Aeroflot, Asiana, Awas and Yemenia, to opt for either the A330neo or the A350-900.

New sole powerplant

The new aircraft will have minor aerodynamic modifications to the upper belly faring, as well as an increased wing span. The traditional A330 winglets will also be replaced with the more-efficient A350 winglets. The biggest change, however, is a new engine, the Trent 7000.

The secret behind the rush of orders and the aircraft's success has been the speed at which Airbus has been able to introduce a new engine. Rolls-Royce's Trent 7000, which will power the A330neo, is based on two engines already in development: the Trent 1000-ten, which is being tested for the 787, and the Trent XWB, the engine that will eventually power the A350.

The engine will offer the same level of thrust as the existing Trent 700, but it will benefit from some of the Trent 1000-ten's key features. These include next-generation Fadec and EHM systems, plus Enables systems to allow easier maintenance of the fan case. By using the Trent 1000-ten low hub-tip ratio fan, Rolls-Royce states it has doubled the bypass ratio compared with the Trent 700 from five to 10. The new engine also benefits from the Trent 1000-ten's IP off-take system.

The Trent 7000 will also borrow technology from the Trent XWB, including the engine's lightweight blisks in the compressor and, crucially, the Trent XWB's core compressor. This, states Rolls-Royce, will improve the Trent 700's 36:1 pressure ratio to 50:1 on the new Trent 7000.

Cheaper engine to run

The new engine is heavier than its Trent 700 predecessor. Rolls-Royce states it will weigh an extra 3,500 pounds but the original equipment manufacturer insists this additional weight is more than compensated for by fuel savings.

The manufacturer claims all of the improvements mean the engine will offer 10% improvement in specific fuel consumption, which equates to about an 11% fuel burn efficiency. In other words, the bulk of the 14% fuel burn savings promised by Airbus on the A330neo.

Rolls-Royce says operators using the Trent 7000 could save up to $60 million compared with a Trent 700 over a "typical aircraft utilization" period of 25 years. Part of these savings include fewer noise charges because the engine is about 50% quieter than the Trent 700.

Crucially, Rolls-Royce has stated that it is offering "similar" maintenance packages for the Trent 7000. "If you purchased an A330ceo with a Trent 700 and an A330neo with a Trent 7000 and you wanted a new proposal from me to offer you a total care, including the core services and life-limited parts, then the rates that I would offer you would be comparable. They would be very similar," confirms Rolls-Royce's customer marketing vice-president Richard Goodhead.

The new engine is a "low-risk programme", according to Goodhead. He points out that a lot of the technology and architecture will also be proven by the time the A330neo goes into service. The first engines will be built and tested next year. The engines will be built for flight testing for 2016 with engine certification in the second quarter of 2017. Airbus promises that operators will be able to fly the A330neo from late 2017.

Editor
Dickon Harris
+44 (0)20 7779 8853
dharris@euromoneyplc.com

Senior reporter
William Mace
+44(0)20 7779 8242
william.mace@euromoneyplc.com

Reporter
Joe Kavanagh
+44(0)20 7779 8072
joe.kavanagh@euromoneyplc.com

Reporter
Michael Allen
+44(0)20 7779 8029
Michael.allen@euromoneyplc.com

Technical editor
Geoff Hearn

Group sub editor
Peter Styles Wilson

Production editor
Clare Wood

Subscriptions manager
Chris Welding
+44 20 7779 8015
chris.welding@euromoneyplc.com

Publisher
Graham Sherwood
+44 (0)20 7779 8857
gsherwood@euromoneyplc.com

Advertising Executive
Ben Sharpington
+44 (0)20 7779 8231
bsharpington@euromoneyplc.com

Business group manager
Andy Cook
+44 (0)20 7779 8207
andy.cook@euromoneyplc.com

Divisional director
Roger Davies

SUBSCRIPTIONS / CONFERENCES HOTLINE
+44 (0)20 7779 8999 / +1 212 224 3570
hotline@euromoneyplc.com

CUSTOMER SERVICES
+44 (0)20 7779 8610
Nestor House, Playhouse Yard, London, EC4V 5EX

Executive chairman: Richard Ensor
Directors: Sir Patrick Sergeant, The Viscount Rothermere, Neil Osborn, Dan Cohen, John Botts, Colin Jones, Diane Alfano, Christopher Fordham (managing director), Jaime Gonzalez, Jane Wilkinson, Martin Morgan, David Pritchard, Bashar Al-Rehany
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THE ENGINE GUIDE

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Engine News 2014

JULY

PW150C for MA700

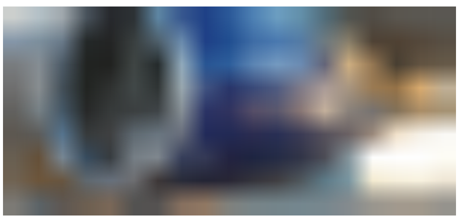
Engine manufacturer Pratt & Whitney Canada and Chinese aircraft company Avic announce at the Farnborough Airshow that the PW150C engine will power the Chinese manufacturer's new MA700 regional turboprop. Both companies say this is a major milestone for the recently launched aircraft.

Emirates and GE agree $13bn service contract

Emirates signs a 12-year agreement with General Electric (GE) for the maintenance, repair and overhaul of its new GE9X engines that will power the carrier's 150 Boeing 777X aircraft. The agreement is valued at more than $13 billion over the life of the contract.

The agreement for the 300 GE9X engines announced at the 2013 Dubai Air Show is worth more than $15 billion at list price, and is GE's largest order from an airline.

Higher-thrust Trent XWB runs for first time



Rolls-Royce announces the first run of its higher-thrust version of the Trent XWB.

The 97,000lb-thrust Trent XWB-97 is the sole powerplant for the Airbus A350-1000 aircraft. The engine will begin test flights in 2016 and entry into service is due in 2017.

The increased thrust is achieved through a combination of new high-temperature turbine technology, a larger engine core and advanced fan aerodynamics, allowing Airbus to increase the A350-1000 payload range and maximum take-off weight.

The Trent XWB, which is specifically designed for the A350 XWB, has amassed more than 1,400 orders.

EasyJet orders 270 CFM engines

EasyJet places an order with CFM for 270 engines to power its firm order of 100 A320neo aircraft and 35 A320ceos.

The carrier ordered 200 Leap-1A engines for the A320neos and 70 CFM56-5Bs for the A320s. CFM values the firm engine order at more than $3.3 billion at list prices.

EasyJet operates a fleet of 225 A320-family aircraft, all of which are powered by CFM56 engines.

Airbus selects Trent 7000 for A330neo

Rolls-Royce announces that Airbus has selected the new Trent 7000 as the exclusive engine for the newly launched A330neo.

The Trent 7000 is the seventh member of the engine family, which has accumulated more than 75 million flight hours.

The new engine is in the 68,000lb- to 72,000lb-thrust class. The manufacturer says it will deliver a step change in performance and economics compared with the current version of the A330 powerplant. Rolls-Royce is targeting a 10% improvement in specific fuel consumption and halving of perceived noise.

The first engine test run for the Trent 7000 is planned for 2015, with certification expected in 2017, supporting an aircraft entry into service in the fourth quarter of 2017.

Rolls-Royce says the engine design draws on existing architectures and expertise, which are the result of ongoing research and development investment.

CFM forecasts record year

CFM International says it is on track for a record year, with the company logging orders for a total of 2,071 engines through June, including 1,017 CFM56 engines and 1,054 Leap engines.

The current record, set in 2013, was for 2,723 engines valued at more than $31 billion at list price.

JUNE

CFM ground tests Leap-1B engine

CFM International ground tests its first Leap-1B engine. The manufacturer reports that after a few break-in runs, the engine is running smoothly and has reached full take-off thrust.

The ground test marks the beginning of the engine's two-year programme towards certification in 2016, before entry into service on 737 Max aircraft in 2017.

Rolls-Royce announces $1.7bn share buyback

Rolls-Royce says it will return £1 billion ($1.7 billion) to shareholders in the form of a share buyback.

Asked about future acquisition plans, chief executive officer John Rishton told reporters: "We have no plans for any material acquisitions at present."

Willis Lease and Casc launch joint venture

Engine lessor Willis Lease Finance Corporation and Chinese aviation supplier China Aviation Supplies Import & Export Corporation (Casc) launch Casc Willis Engine Lease, a new 50-50 joint venture.

The new company will be dedicated to supplying Chinese airlines with engine support solutions and creating an engine resource sharing platform.

CASC Willis will be established within the Shanghai pilot free-trade zone in order to take advantage of the evolving governmental support programmes offered to companies there.

First PW1200G engine delivered for MRJ

Mitsubishi Aircraft Corporation takes delivery of the first PurePower PW1200G engine at the Mitsubishi Regional Jet's (MRJ) assembly factory in Japan.

NEWS

Engine News 2014

Mitsubishi says the delivery of the engine "marks a major milestone" towards the completion and final-assembly process of the 70-seat to 90-seat next-generation aircraft.

Rolls-Royce hit by Emirates Airbus cancellation
Rolls-Royce, the sole engine provider for the A350, says Emirates' cancellation of its order of 70 A350 XWB aircraft will cut the engine manufacturer's order book by $4.36 billion. Emirates does not use Rolls-Royce powerplants on its fleet of A380s.

MAY

Engine turbine failure identified in CSeries flight test incident
Bombardier says a suspected problem in the low-pressure turbine (LPT) led to a sudden loss of power and uncontained failure of a Pratt & Whitney PW1500G on the first CS100 test aircraft during ground runs.

The event, which occurred on the number one (left) engine, also caused damage to the airframe and led to the grounding of the CSeries test fleet.

Rolls-Royce wins *Airfinance Journal* award
Rolls-Royce & Partners Finance wins *Airfinance Journal* engine deal of the year award for its successful pricing of $700 million-worth of senior secured notes in the US private placement market. The deal, a debut issuance for Rolls-Royce, was a unique transaction that used the same collateral package for multiple classes of financing.

First production Trent XWB dispatched
The first Trent XWB for installation on a production Airbus A350 XWB is dispatched from the engine manufacturer's factory in Derby, England.

The initial A350 XWB will be delivered to Qatar Airways. The airline has 80 of the aircraft on order (43 A350-900s and 37 A350-1000s).

Rolls-Royce says the Trent XWB is 16% more efficient than the first-generation Trent engines that entered into service in 1995.

APRIL

Ontario Teachers fund new GE engines programme
General Electric (GE) Aviation announces that the Ontario Teachers' Pension Plan will help finance the development of the GE9X engine. The engine is the powerplant for Boeing's new widebody 777X aircraft.

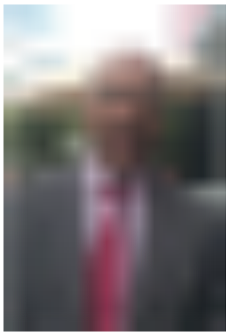
The pension plan will link up with the Development Bank of Japan to fund the engine programme, which GE says will offer a 10% improvement in fuel consumption over the existing GE90-115B engine.

"Our assessment of this programme has given us belief in the promise of GE9X's technologies and commercial potential," said Michael Wissell, Teachers' senior vice-president, public equities.

GEnx MRO network takes shape
General Electric Aviation announces new overhaul facilities for the GEnx engine, including an agreement with Air France-KLM and a new joint venture with Evergreen Aviation Technologies called GE Evergreen Engine Services.

MARCH

GE and CFM promise 'open' MRO network
General Electric (GE) Aviation and CFM International say they will keep an open maintenance, repair and overhaul (MRO) network for third-party MRO shops for both Leap and GEnx engines.



CFM plans 20 test Leap engines in 2014
Engine manufacturer CFM states it will build 20 Leap engines to test in 2014 before the engine enters into service in 2016 and 2017.

Speaking at the Istat Americas conference, Jean-Paul Ebanga, president and chief executive officer, CFM International, confirmed that at least 20 Leap engines across the three models – the Leap 1A, 1B and 1C – would be tested and "tortured" a year ahead of their respective expected entries into service.

The powerplant for the A320neo – the Leap 1A – is expected to enter service in 2016.

The Leap 1C powers the Comac C919 and the Leap 1B powers the 737 Max, which is expected to enter into service in 2017.

FEBRUARY

Rolls-Royce unveils new engine designs
Rolls-Royce announces plans to develop two next-generation, more-efficient Trent engine designs.

The first design, Advance, will offer at least 20% improvement in fuel burn and CO_2 emissions than the first generation of Trent engine. The manufacturer estimates it could be ready from the end of this decade.

JANUARY

V2500 programme hits 6,000 milestone
IAE International Aero Engines announces a new production milestone when it ships its 6,000th V2500 engine. The engine was installed on an A320 and delivered to JetBlue Airways.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is this thing on?
The PurePower® Geared Turbofan™ engine is by design the quietest in its class. We reduced the noise footprint by 75%, or as much as 20 decibels below today's strictest standards. Where jets are concerned, that's practically a whisper. But the message? Loud and clear: lower noise fees, access to more airports, happier airport neighbors, shorter flight tracks and extended curfew operation. Simply a better, quieter engine at its core. (But you didn't hear that from us.) Learn more about the PurePower® PW1000G engine at PurePowerEngines.com.
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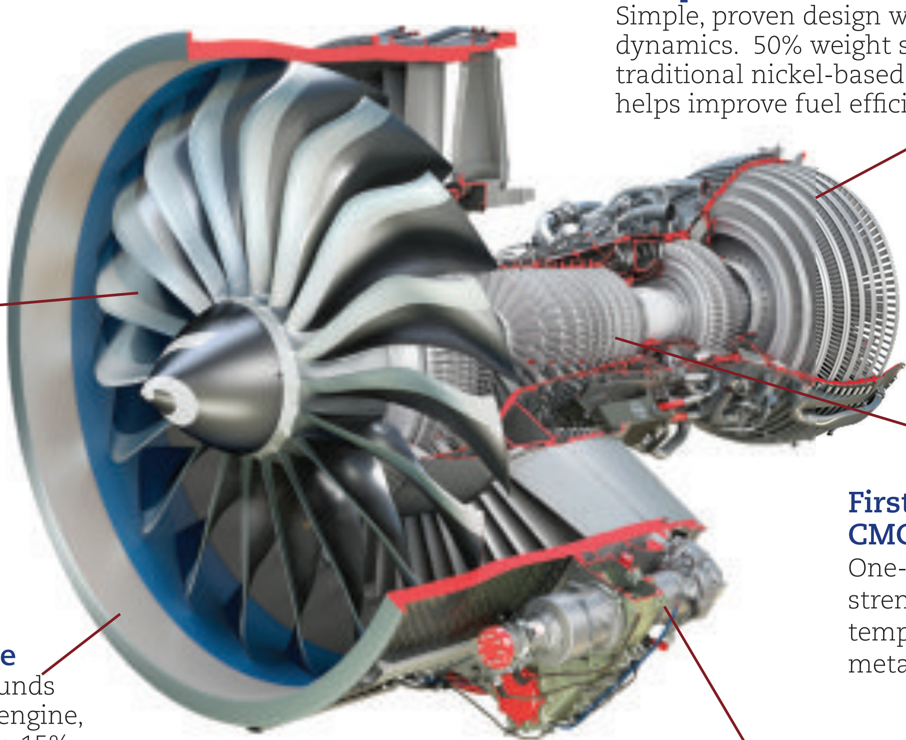
ENGINE COMPARISON

CFM's LEAP engine



Ultra high efficiency low-pressure turbine with TiAl
Simple, proven design with advanced aerodynamics. 50% weight savings compared to traditional nickel-based alloy parts, which helps improve fuel efficiency.

3-D woven composite fan blades
Light-weight and highly durable, these carbon fiber blades are virtually maintenance free; the wide-chord design makes the fan highly efficient.

First commercial use of CMCs in HPT shroud.
One-third the weight, 2X the strength, and 20X more temperature capability of metal.

Composite fan case
Contributes to 500 pounds of weight savings per engine, helping LEAP achieve a 15% fuel efficiency improvement.

Application of lean burn, lower emissions combustor with additive fuel nozzles.
A revolutionary design, these nozzles are the first to use additive manufacturing for a highly sophisticated, critical engine part.

What is the improvement in fuel burn of the Leap engine over the equivalent current-generation models?
The Leap engine will provide a 15% improvement in fuel efficiency compared to today's best CFM56 engines. The carbon fibre composite fan and fan case are much lighter than the metallic equivalent, enabling a larger fan diameter to achieve higher propulsive efficiency, which contributes half of the overall improvement. The other half is obtained from ceramics matrix composites and other materials in the core that allow the Leap engine to operate at higher air temperatures for thermal efficiency. Advanced cooling and coatings keep the metal temperature the same as the CFM56 engine, so there is no sacrifice in engine durability.

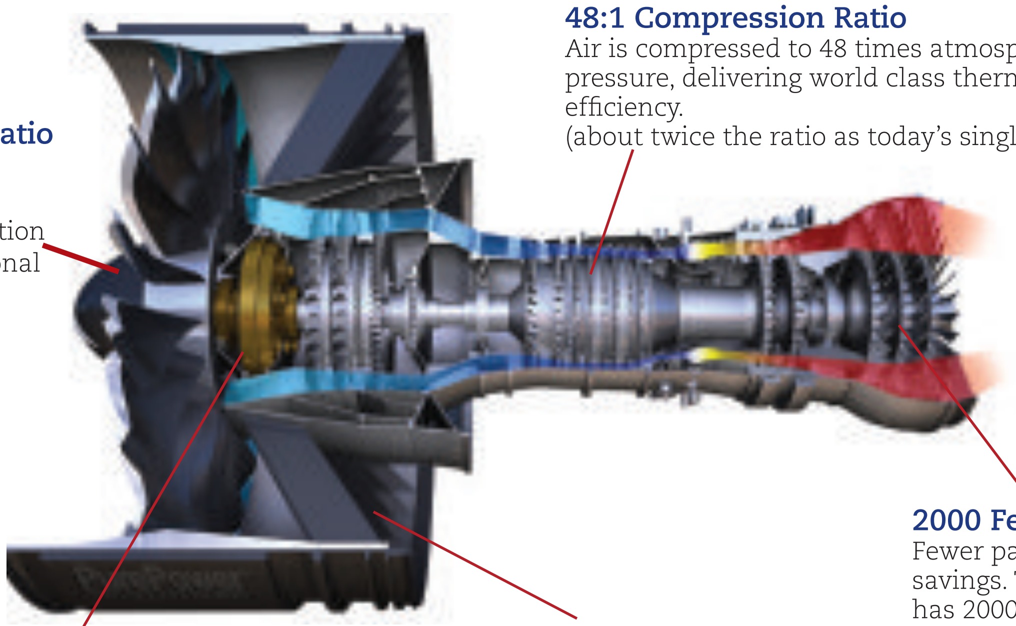
What do you believe are the key advantages of your engine versus the main competitor?
The Leap engine provides several advantages versus the competition, from better fuel efficiency, to higher reliability and lower maintenance costs. The Leap direct-drive architecture is simple and proven in more than 700 million hours of experience, providing unmatched reliability. Fourth-generation aerodynamics in the fan and the core make the engine more fuel efficient. CFM predicts the Leap will be 3% more efficient than the competition over the life of the product. The revolutionary combustor design has a lower temperature for engine durability. Lightweight materials throughout provide efficiency and durability resulting in 20% longer time on wing.

How will the maintenance costs of the new-generation engines compare with their predecessors?
The current CFM56 product line has the lowest maintenance costs in the industry. CFM is committed to keeping Leap maintenance costs at those same levels, all while providing a 15% improvement in fuel efficiency, with an equivalent reduction in CO_2 emissions; 50% margin to CAEP/6 NOx emissions requirements; double-digit improvements in noise; and combined with CFM's legendary reliability.

How competitive will the engine overhaul market be?
CFM believes that competition helps drive down costs. Consequently, the Leap engine will have the most competitive MRO [maintenance, repair and overhaul] network in the industry.

ENGINE COMPARISON

Pratt & Whitney's PurePower engine



What is the improvement in fuel burn of the new-generation engine over the equivalent current-generation models?
The PurePower® engine improves fuel burn by 16% compared to today's best engines. Combined with the benefits of a new, advanced aircraft the fuel burn reduction can be even greater more than 20% versus current aircraft.

What do you believe are the key advantages of your engine versus the main competitor?
From lightweight fan blades, cutting-edge materials and coatings, to advanced airfoil cooling, the suite of technologies in P&W's Geared Turbofan™ engine delivers the high efficiency with lower temperatures that drive improved durability with a lower overall cost of ownership. Pratt & Whitney has completed more than 9,300 hours of testing across the PurePower® engine family, including more than 1,400 hours of flight testing that have validated its promise to the industry to deliver significant improvements in fuel efficiency, environmental emissions, noise and thrust.

How will the maintenance costs of the new-generation engines compare with their predecessors?
The geared architecture provides a fundamental maintenance advantage relative to the competing conventional engine. The geared architecture enables a more efficient higher speed low-pressure spool (LPC and LPT). This leads to less than six fewer stages and more than 2,000 fewer airfoils. As more work is moved to the low-pressure spool, the engine core (HPC, Burner, HPT) will run cooler than a conventional design. This is critical for maintenance and durability and reduces the amount of cooling air needed for the high-pressure turbine. Since the majority of the engine maintenance is driven by the engine core, unloading the engine core via the fan drive gear system provides a physics-based solution.

How competitive will the engine overhaul market be?
We anticipate strong competition in the overhaul market, and it's good for the customers. We do see a shift to more managed care programmes like our PureSolution® services for the PW1000G. As an OEM [original equipment manufacturer] we see this as a positive industry trend as both the OEM and customer are fully aligned on optimizing the maintenance intervals to keep engines flying, incorporating upgrades to lower fuel consumption and increase reliability while providing a predictable monthly cost over the engine life cycle. We have been working closely with operators and lessors to define a full range of offerings that can be tailored to specific customer needs. We are also seeing a trend to more lessor maintenance agreements that can be passed on to their customers.

ENGINE DEAL OF THE YEAR

Deal of the Year 2014

In October Rolls-Royce & Partners Finance (RRPF) successfully priced $700 million-worth of senior secured notes in the US private placement market (USPP). The deal, a debut issuance for RRPF, was a unique transaction that used the same collateral package for multiple classes of financing. RRPF wanted a mix of fixed- and floating-rate notes. The depth of the private placement market is typically fixed rate. Citi proposed to use a swapped note solution uniquely available in the USPP market.

The US private issuance relied on the same collateral pool as a $1.05 billion bank facility that RRPF closed two years ago, with both deals done under the same documentation. The documentation in the deal provided the flexibility to use different classes of financing, including bank debt, public bonds and private placements under the same collateral package.

This was slick financing that managed to get a rating outcome that was only one notch behind Rolls-Royce's corporate rating, ensuring a phenomenal execution in the capital markets. Despite the absence of a direct Rolls-Royce guarantee over RRPF's debt, the company achieved an A- rating from Standard & Poor's.

Using floating-rate notes allowed a much better interest rate match for RRPF, and the firm managed to maximize the amount of investor appetite for the deal without paying a premium. To make the transaction possible in the usually fixed-rate US private placement market, the advisers introduced swapped asset notes to accommodate the large amount of floating-rate notes. RRPF issued the mix of fixed and floating notes in three tranches. The company launched with $250 million notes with an average tenor of 9.4 years. The notes are set to mature in 2020, 2023 and 2025.

Miguel Picache, Citi's managing director and head of private placements, says: "The USPP market's strongest and deepest appetite is for fixed-rate debt. This transaction was also innovative in that it applied the investor cross-currency swapped note structure to allow RRPF to achieve its goal of raising over $500 million uniquely in floating-rate notes."

Competitively priced, the deal was key strategic financing for the firm. Mark Brady, who led the financing at RRPF, says: "This is the first time RRPF has issued in this market, and the notes were four times oversubscribed. Of the $700 million raised, we obtained $505 million floating-rate notes from the PP market. We see this as quite an achievement."

Munawar Noorani, Citi's aviation head for Europe, the Middle East and Africa, says: "Intellectually, to me the more interesting part is the documentary innovation which started back in 2011 when RRPF did its $1.05 billion bank deal. Mark Brady had this vision that one security document should work for multiple classes of debt, so when the bank facility was being structured much thought was put into creating a documentation that would be acceptable to the USPP market and perhaps eventually the public debt market. The success of the USPP is proof that you can create a security structure and one documentation for multiple classes of debt."

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SPONSORED EDITORIAL

CFM's LEAP into the future

Jamie Jewell
Director, Strategic Communications
CFM International

September 4 2013 was a big day for CFM International and the thousands of employees around the world who had devoted countless hours getting there. On that day the company started testing the first full LEAP engine at GE's facilities in Peebles, Ohio, two days ahead of a schedule that had been set in April 2010.

It was a tremendous achievement but, rather than the culmination of a lot of hard work, it was only the beginning.

Over the next three years CFM will run a total of 60 different engine builds and log more than 40,000 engine cycles – the equivalent of 15 years' commercial airline service – before the first LEAP engine is delivered to an airline customer.

"This is the biggest certification programme in the history of CFM, or either of our parent companies for that matter," says Allen Paxson, CFM executive vice-president. "I am not sure anyone in the industry has ever undertaken such a monumental programme. But we wouldn't have it any other way.

"We believe that the LEAP engine will be the best-in-class in the single-aisle arena. Our job over the next three years is to prove it. We are putting this engine through its paces to ensure that it will do everything we have promised and more. If there are problems, we intend to find them on our test stands rather than on our customers' airplanes," he adds.

The LEAP engine certification programme is proceeding on schedule. As of June there were five engines, including the LEAP-1A, LEAP-1B and LEAP-1C variants, on test and the company was on track to have a total of 20 engines on test by year end.

A major milestone in 2014 was the start of the LEAP-1B engine testing on June 13, three days ahead of schedule, at Snecma (Safran) facilities in Villaroche, France. As with the LEAP-1A, the LEAP-1B engine started the first time and, after a series of break-in runs, was running at full power in a matter of hours.

This engine completed its first ground test programme in early July, validating all of the advanced technologies in the engine, including the carbon fibre composite fan, the twin annular pre-mixing swirler (TAPS) combustor, the CMC shrouds and the high-pressure turbine (HPT) blade design. The engine demonstrated smooth mechanical operation, robust starting and excellent operability.

In January 2014 the LEAP-1A – the very first LEAP engine tested – successfully completed a series of early icing tests, one year ahead of required certification testing. The engine behaved very well in extremely harsh conditions, validating pre-test predictions and reinforcing the company's confidence that the engine will certify on time, and meet the performance and reliability promises made to its customers.

Another LEAP-1A engine is undergoing early block testing. This is one of the most gruelling the engine will endure. During the course of this test the engine is operating at triple redline: maximum fan speed; maximum core speed; and maximum exhaust gas temperature. Results to date are in line with pre-test predictions and are giving the company even more confidence going into the certification block test, scheduled to begin year-end 2014.

Both the LEAP-1C and LEAP-1A configurations were on track for flight testing on GE's modified Boeing 747 flying testbed at its facilities in Victorville, California. The LEAP-1C completed a ground test programme in early July, and will be the first variant to fly.

"We couldn't be happier with the results we are achieving," says Cédric Goubet, CFM's executive vice-president, "and our team continues to do a phenomenal job of keeping this programme on schedule. We are subjecting this engine to conditions more severe than it will likely ever see in commercial service, and it has met every challenge beautifully. As our engineers say, this engine wants to run and we have had many instances of it running 20-plus hours a day, non-stop. The LEAP engine will absolutely deliver everything we have promised and more."

Through the end of June the five LEAP engines had accumulated 1,500 cycles in the early stages of testing.

This comes after nearly six years of exhaustive component and rig testing, including three core tests (525 total hours); a 5,000-cycle endurance test on the composite fan; bird ingestion and fan blade-out rig tests; more than 5,000 hours of TAPS combustor testing; and about 4,100 cycles testing LEAP hardware in a GEnx engine, including turbine blades and CMC shrouds.

The LEAP engine promises to bring a 15% improvement in fuel efficiency, 50% lower emissions and double-digit improvements in noise.

"The LEAP engine is a really exceptional motor," says Paxson. "With each cycle we log our confidence in the technology choices we made continues to grow. We believe that the LEAP engine will provide the best fuel efficiency in its thrust class out of the box and continue to retain that advantage over the life of the product. We can't wait to get this engine into service."

The foundation of the LEAP engine is heavily rooted in advanced aerodynamics, environmental and materials technology development programmes. This revolutionary engine will provide 15% better fuel consumption and an equivalent reduction in CO2 emissions compared with today's best CFM engine, along with dramatic reductions in engine noise and emissions. All this technology brings with it CFM's legendary reliability and low maintenance costs.

The engine programme was officially launched in July 2008, and has been selected as the sole powerplant for the Boeing 737 Max and Comac C919, China's new 150-passenger single-aisle aircraft, and it is one of two engine options on the Airbus A320neo. To date, CFM has garnered orders for nearly 8,000 LEAP engines across these three platforms.

The LEAP development programme has four guiding principles with ambitious goals for each: LEAP is designed to provide 15% better fuel efficiency; reliability and maintenance costs equivalent to the current CFM56 family, which are agreed to be the best in the industry; NOx emissions that are 50% lower than CAEP 6 protocols; and noise levels that are 10 to 15dB lower than Stage 4 requirements.

Q&A: BOBBY JANAGAN

Mid-life engines attract more interest

Bobby Janagan, vice-president and general manager of Rolls-Royce and Partners Finance, speaks to Airfinance Journal on what he sees as a buoyant market for engine leasing.

Airfinance Journal: What has changed since last year? Is the demand for spare engines still flat? Is the leasing market still favoured?
Bobby Janagan: On the back of the 2008 credit crisis and the subsequent broader economic downturn, the entire engine market came down. Repossessions were up and orders were also slower to come in. But that has now changed, and we are seeing a much more optimistic environment where aircraft utilization is up and demand for capacity, especially in Asia, is up too. In turn this means more engine removals and refurbishments, and so the spares market is pretty buoyant as a consequence.

What is the secondary market for spare engines doing? How has this changed and what might happen next year?
The secondary market is pretty much a function of how the broader fleet is used and operated: if more engines are used then that is reflected in the secondary market and in rentals. Overall, aircraft use is up, especially in the narrowbody space where typically their aircraft have more flying hours. That is good for the secondary market.

What about demand for new engines?
The market for new engines is fairly flat. There are no significant volumes yet because airlines simply do not need to take on board new engines at the present time. In addition, the majority of incremental new deliveries are managed with existing spare engines. This will, however, change in the next few years, around 2015/2016 when companies will be looking to take on new aircraft types such as 787s, A320neos and A350s. There will also then be demand for new type of engines to cover their spares requirements. The current ratio is one spare to around five aircraft.

To what extent is competition from new manufacturers affecting the market?
The leasing community needs to be comfortable that any new entrant to the market is reliable when it comes to performance and other objectives. The proof is in the order book size and diversity of operator base. When this happens then they will start to attract attention away from established and trusted manufacturers.


Bobby Janagan, General Manager, Rolls-Royce & Partners Finance.

What are the major innovations in technology seen this year and what will be next to market (such as the Advance and Ultra fan systems to reduce fuel burn and CO2 emissions)?
All the technological advances currently in the pipeline are around enhancing performance and lowering fuel burn and thereby bringing down overall cost of operation and ownership.

What is the market like for midlife aircraft, given the trend for new aircraft to be offered to less creditworthy airlines?
Between 2008 and 2013, due to lower passenger demand and airline bankruptcies, there was an excess supply of aircraft in the market. As a result, aircraft owners didn't have the luxury of differentiating between the creditworthiness of airlines when they were placing aircraft, hence numerous new aircraft were placed with lower creditworthy airlines.

This year there is a change of behaviour and market discipline is returning. New aircraft are going to airlines with better credit ratings, and mid-life aircraft with lower book values are also getting placed.

During the downturn banks shied away from mid-life aircraft and pretty much focused on newer aircraft. But with greater confidence in the economic recovery and intense competition in business, banks are slowly returning to finance mid-life aircraft.

What about maintenance and original equipment manufacturer (OEM) agreements? What is the relationship between the lessor and the manufacturer? What can third parties add? Is this model now the preferred path for the foreseeable future?

The majority of airline customers prefer OEM-based power-by-the-hour maintenance agreements as risk is transferred to the OEM for a fixed dollar per hour basis. The OEM is generally accepted as the best-placed to fix, maintain and upgrade the engine because they were the ones who designed and built it in the first place. But this total care proposition is not just about fixing things; it's also about maintaining engine health and extending the overall life of that engine through maintenance and by installing upgrades and spare parts.

In fact, engine maintenance is now all about taking a more holistic view and being able to care for ageing engines, as well as newer ones. With an engine that might have just five to 10 years remaining, then the right maintenance package can make the difference for the lessor in being able to secure an acceptable return by keeping the engine flying for longer and extracting the maximum possible value. This is especially important given that the residual value of engines is very hard to extract and that the market for component parts tends to be relatively small. This is especially the case in the widebodied market, simply because fleet sizes are smaller in the first place and the market is therefore lacking an economy of scale.

The majority of power-by-the-hour agreements are designed with airline customers in mind. Now there is a recognition that these agreements need to be tailored to accommodate asset owners' aspirations as well. Rolls-Royce is gathering service requirements to design a flexible product. It is called TotalCare Flex.

We have seen lots of new investors for aircraft. Are we seeing the same thing for engines?

This has always previously been a five-six lessor club but we are now seeing lots of investor interest from Japanese investors. Japan is a nation of high savings but the returns are very low in the domestic market or from Japanese government bonds. As a result, the government is encouraging Japanese companies to expand abroad, and banks and trading houses are now making investments. Similar to Japan, the Chinese government is encouraging development of domestic aircraft lessors, many of whom are flexing their muscles in the international market. Aviation is an attractive market to invest in because there is a great deal of standardization, long economic life, high value capital assets and regulation along with configurability of deals and portability of assets.

"During the downturn banks shied away from mid-life aircraft and pretty much focused on newer aircraft. But with greater confidence in the economic recovery and intense competition in business, banks are slowly returning to finance mid-life aircraft."

Are we in a sellers' or a buyers' market for spare engines?

The upward trend of positive economic sentiment and positive fleet utilization have made a positive impact on engine prices and rentals. However, there is an intense competition in the market; engine leasing is a mature industry and entry barriers are low. In addition, the engine leasing market size is quite small at just $3 billon a year compared to aircraft leasing. The established lessors are likely to evolve with new product offerings by leveraging their platform to compete against new entrants.

However, in the next 20 years about 30,000 new aircraft will be delivered and a significant quantity of aircraft will go to emerging markets. The size of the pie is getting bigger in the medium to long term, and a broader investor/lessor base is good for the aviation industry.

What are the financing returns like now for those investing in engines? Is it still attractive enough? Will we see more investors in this space?

Lease rates are typically 20% lower compared to aircraft lease rentals. Lease rate factors for long-term leases are currently about 0.65% to 0.75% for narrowbody and 0.75% to 0.85% for widebody engines. These lease rates will vary depending upon the overall deal terms. Lessee creditworthiness, the length of the lease term and deal terms, including the redelivery conditions, will all additionally influence the lease rates. Aircraft lessors and parts traders are moving vertically. Secondly, due to the price bracket of engines, it is an affordable range for many. As a result, there will be many new entrants in this space.

However, narrowbody engine lease rates have been sluggish in the last few years but due to increased fleet utilization this year, lease rates are improving. Widebody engines, meanwhile, didn't experience a significant drop in fleet utilization during the downturn, and therefore the lease rates have been stable throughout the downturn

ENGINE SURVEY 2014

Engines back in demand

This year's survey reflects an improvement in engine trading and leasing. Joe Kavanagh reports.

Engine financiers say that the engine market has improved in the past year. In particular, they note more activity in engine trading and leasing. Although the market for engines is considerably smaller than the aircraft market, with just a handful of key players, the assets are favoured by investors because of the way they hold their value.

This year's engine poll reveals some unsurprising leaders. The CFM56-7B remains on top again for investor appeal with 6.6, compared with 6.4 last year and in joint first place with the GEnx. The GE90 and CFM56-5B are also successful, each with a score of 5.6.

Improvement in trading and leasing

Industry heads note that leasing and trading rates are improving and there is more activity in the market than last year. This is because of several factors, all of which are ultimately benefiting engine lessors.

Improvement in the global economy has bolstered commercial aviation through increased passenger demand. The International Air Transport Association has stated that global passenger traffic results for May have increased by 6.2% compared with May 2013. This growth, and increased airline confidence for future traffic, means airlines need more aircraft, and crucially more engines. As a result, lease rates for spare engines have steadily risen over what has been a fairly flat few years.

"The market for spare engines has firmed up considerably. On average, leasing rates for spare engines are up about 10% to 15%. The market is good, it's better, there's new competition," says Joseph O'Brien, executive vice-president of sales at the Engine Lease Finance Corporation.

The second driver is the presence of more investors looking for hard assets that offer a return. This investment has been through both the leasing channel and the part-out sector. More money in the sector in general has spurred more trading of engines.

"For trading, of course, the main driver is that we have seen more money in the market, which means more investors asking for investment in aviation assets," agrees Lothar Ratei, a partner with GSI Fonds.

Last year's engine poll noted that the market was beginning to rebalance after a period of spare engine oversupply. Insiders agree that, on balance, this trend has continued. There were large numbers of spare engines available for the V2500-AS, for example, after technical difficulties early on in the programme led to the production of more spares. But this year the engine received a score of 4.8, an improvement from last year's 4.1.

An inside view of the CFM56-5B - a popular engine according to engine investors.

Mature engines doing well

The market for mature engines saw activity this year as airlines and lessors retired older aircraft to make way for newer models. Hooman Rezaei, president of the International Aircraft Engine Association (IAEA), says this market has seen a boost.

"There is a trend in the mature engine market that people are selling engines and trades are happening, and the market is going to continue: what's going to happen is older aircraft are going to retire as new aircraft models come in," says Rezaei.

He adds that the market for mature engine models on green time (the time an engine can spend on lease before it is parted out) has improved "significantly" over the past year, for the same reason. The market for sunset engines such as PW4000s and CF6-80s, which have been mature for a few years, has seen a lot of transactions.

IAEA has recently set up the world's first engine cloud (aeroenginecloud.com), a one-stop online shop that Rezaei hopes will open up the market by allowing lessors, airlines and manufacturers to lease and bid for engines at a single online location.

Ratei agrees that some older engines have done well. "We have found a bit of a resurgence for some of the older engines like -5A3s

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"There has been a resurgence in leasing and requirement for parts"

Lothar Ratei, partner at GSI Fonds

and -5C4s, where we thought the market might actually go away. But there has been a resurgence in leasing and requirement for parts," he says.

OEMs and aftermarket

As *Airfinance Journal* noted earlier this year, original equipment manufacturers (OEMs) are becoming increasingly dominant in the engine aftermarket. Engine manufacturers offer airlines fixed-rate flight-hour programmes to ensure support for practically all of their engine maintenance. Airlines benefit from flight-hour agreements because they ensure predictable maintenance costs.

These all-inclusive agreements help manufacturers recoup their expensive development costs for new engines. Manufacturers sell engines effectively at cost price, relying heavily on a mix of maintenance agreements, shop visits and parts sales to recoup the development costs.

The aggressive control of the aftermarket by the OEMs against maintenance, repair and overhaul (MRO) shops or parts providers helps conserve vital revenue generation. It is no wonder that all-inclusive support packages have grown dramatically in the past decade and are estimated to cover nearly 50% of all new aircraft delivered.

The losers in this trend are independent MRO providers which are unable to compete with OEMs. In addition, the increasing control of the aftermarket by the engine OEMs poses a problem for the residual values of engines. Engine investors speculate that OEM dominance will only increase for the many engine programmes getting certification.

Ratei says: "In the future, of course, I can imagine that P&W [Pratt & Whitney] will maintain a huge percentage of the aftermarket, and they will try to keep the clients and their engine needs under their umbrella. Will they do that with the Leap engine? I'm not sure. But we know that it is their policy to keep as much as possible."

Rolls-Royce, CFM and Pratt & Whitney all have new engines in development. At present there is worryingly little detail about what the maintenance packages for these engines will look like. When questioned by *Airfinance Journal* at the Farnborough Airshow, Jean-Paul Ebanga, CFM's chief executive officer, confirmed that there would be an "open" MRO network for third-party MRO shops for the Leap engines but did not specify how many MRO providers this would include.

At an industry conference in March, Lloyd Thompson, general manager sales of GE Aviation USA, said there would be competition on the GE9X. "We have an open MRO network. MRO shops will continue to compete."

However, he added that the GE expected fewer MRO shops to be servicing their GE9X than their existing MRO network on current engine types.

Best-performing engines

The CFM56-7B, the only engine that equips the Boeing 737, is unsurprisingly high on the scale of investor appeal. As the engine powering one of the world's most popular narrowbodies, there is a large market for this model.

This year's poll, which has seen the -5B and -7B score highly, corroborates what insiders have also said: the larger the market for an engine, the better an investment it becomes.

"-5Bs and -7Bs are the biggest MRO market at this point as these engines are approaching production cycle maturity," says Rezaei, noting the start of a bow-wave of these engines coming in for shop visits.

One senior lessor is effusive about the -7B's strength as an investment. "If it was up to me, I would do nothing but -7Bs. I would invest in -7Bs all day long if I could get the right prices because it's such an enormous market," he says.

By contrast, the A320 is powered by a variety of engines, including the V2500-A1 and the V2500-A5. The choice means the market for engines to power A320s is split, which perhaps explains why these engines have received a lower score in this year's poll.

Even so, the market for V2500s has also improved this year. O'Brien of Engine Lease Finance Corporation says: "The V2500 is probably the most improved engine this year. The parked Airbus fleet has come back on and the fleet has higher utilization overall."

New leasing competition

Engines are a small market dominated by a handful of players. As such, engine lessors have mentioned increasing competition as another big trend this year. In September 2013 Japan's Sumitomo Corporation and Germany's MTU Aero Engines announced they were teaming up to create two joint ventures to step into the aircraft engine leasing market.

Lessors say V2500 lease rates have improved substantially this year.

MTU Maintenance Lease Services is an 80-20 joint venture providing short- and medium-term leases, while Sumisho Aero Engine Lease, another new venture based in Amsterdam, is offering long-term leases.

Announcing the agreement in September last year, Stefan Weingartner, president of commercial maintenance at MTU Aero Engines, suggested that increased demand was a reason for the establishment of the new ventures. He said: "The increased demand for engine leasing calls for an expansion of our existing leasing business."

O'Brien believes the increase in competition is a good development for lessees in the market for new leasing deals.

"These new competitors are not so much involved in trading because they don't really have portfolios to trade yet, but in terms of new deals it's just another level of competition. So it's driving terms in a more lessee-favourable direction," he says.

As aircraft demand rose over the past year, the demand for spare engines rose with it. More investors are turning to aircraft engines and the market seems more buoyant than this time last year. However, there are some worrying signs on the horizon. The rise of new engine programmes will inevitably have an impact on the residual values for existing engines. What that impact is has yet to be fully understood. For now the spare engine market is enjoying a resurgence but many investors will be watching engine residual values closely.

ENGINE SURVEY

Investors pick their favourites

INVESTOR APPEAL	(out of 7)
CFM56-7B (737NG)	6.6
GEnx (787-8)	6.6
CFM56-5B (A320)	5.6
GE90 (777)	5.6
CF34-10 (E-Jet)	5.4
V2500-A5 (A320)	5.2
Trent 1000 (787-8)	4.8
CF34-8E (E-Jet)	4.4
CF34-8C (CRJ)	3.8
Trent 700 (A330)	3.8
PW150A (Q400)	3.3
Trent 800 (777)	3.2
CF6-80 (747-400, 767)	3.0
GP7200 (A380)	3.0
PW127 (ATR)	3.0
PW4000 (747-400, 767, 777)	2.8
Trent 900 (A380)	2.4
PW2000 (757)	2.3
RB211-535 (757)	2.0
Trent 556 (A340-600)	1.8
CFM56-5C (A340)	1.8
CFM56-3C (737 Classic)	1.6
CFM56-5A (A320)	1.4
Trent 553 (A340-500)	1.4
RB211-524 (767, 747-300/-400)	1.2
V2500-A1 (A320)	1.0
PW6000 (A318)	0.8
JT9D (747, 767-200)	0.6

REMARKETING POTENTIAL	(out of 7)
CFM56-7B (737NG)	6.6
GEnx (787-8)	6.6
CFM56-5B (A320)	5.6
GE90 (777)	5.6
CF34-10 (E-Jet)	5.4
V2500-A5 (A320)	5.2
Trent 1000 (787-8)	4.8
CF34-8E (E-Jet)	4.4
CF34-8C (CRJ)	3.8
Trent 700 (A330)	3.8
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PW2000 (757)	2.3
RB211-535 (757)	2.0
Trent 556 (A340-600)	1.8
CFM56-5C (A340)	1.8
CFM56-3C (737 Classic)	1.6
CFM56-5A (A320)	1.4
Trent 553 (A340-500)	1.4
RB211-524 (767, 747-300/-400)	1.2
V2500-A1 (A320)	1.0
PW6000 (A318)	0.8
JT9D (747, 767-200)	0.6

RESIDUAL VALUE	(out of 7)
CFM56-7B (737NG)	6.6
CFM56-5B (A320)	5.4
GEnx (787-8)	5.4
CF34-10 (E-Jet)	5.2
V2500-A5 (A320)	5.0
GE90 (777)	4.8
Trent 1000 (787-8)	4.6
CF34-8E (E-Jet)	4.2
Trent 700 (A330)	3.8
CF34-8C (CRJ)	3.6
PW150A (Q400)	3.5
CF6-80 (747-400, 767)	3.4
PW127 (ATR)	3.0
PW4000 (747-400, 767, 777)	3.0
Trent 800 (777)	3.0
GP7200 (A380)	2.6
PW2000 (757)	2.5
CFM56-3C (737 Classic)	2.4
CFM56-5C (A340)	2.4
RB211-535 (757)	2.4
Trent 900 (A380)	2.0
CFM56-5A (A320)	1.8
RB211-524 (767, 747-300/-400)	1.4
Trent 556 (A340-600)	1.4
V2500-A1 (A320)	1.4
Trent 553 (A340-500)	1.0
PW6000 (A318)	0.8
JT9D (747, 767-200)	0.6

SPONSORED EDITORIAL

Are Zip-aero-engines the future?

Bobby Janagan, General Manager, Rolls-Royce & Partners Finance.

Some 85% of people travel to work by car in the US, but ownership of cars peaked in 2001 and has been declining since. In the past decade US cities have seen the rise of an alternative way of accessing cars: car-sharing services.

Congested urban areas make it difficult, and occasionally even annoying, to own a car. The asset value drops as soon as it is driven away from the dealership. Other costs of ownership are high gas prices, parking fees, personal property taxes, state inspections and regular maintenance. Cars can be money pits. Car-sharing services offer an alternative way to access a car that is convenient and value for money. Zipcar, one of the pioneers in car sharing, has successfully monetized the trend away from ownership.

There is a similar trend away from ownership of aircraft spare engines. Airlines are increasingly reluctant to tie up large sums of capital in what is a low-utilization asset. Engines are also increasingly reliable. After several years of service, modern engines, thanks to new monitoring and diagnostic technologies, quickly mature to follow a predictable maintenance pattern. In this context the engine leasing industry is ripe for innovation to iron out inefficiencies. Could we shortly see a Zip-aero-engine business?

Airlines are relentlessly driving to reduce costs, and spare engine coverage is an important area of focus. Ideally, airlines only want spare engines on a just-in-time basis for planned and unplanned engine maintenance removal events. However, the providers of spare engines need to have predictable and high asset utilization in order to earn a return from their investment. The optimal solution generally adopted by the industry is for airlines to secure a base load of engines on a long-term dedicated basis, either owned or on long-term lease, and then to source incremental needs through short-term leases.

If airlines and service providers worked closer together by sharing data on coverage requirements and were able to match available capacity more efficiently to the underlying need, then costs could be reduced. In such a world, service providers would need to change their pricing models, perhaps to work more like the airlines' ticket/yield management approach: book early to get cheaper rates.

However, data sharing and pricing is only one part of the puzzle that needs to fall into place for a more efficient world of Zip-aero-engines. There are significant amounts of time spent on back office paperwork at lessors and airlines. Although there is a level of standardization for contracts, such as the International Air Transport Association short-term lease form, and some technical documentation, we need standards on electronic signatures/stamps and the format of key technical data. There is a need for greater digitization and for more-efficient systems of data exchange. Airlines and lessors use lots of different IT platforms and we need to find a way for them to talk to each other.

The industry relies on manual stamps and signatures. Digitization in our industry has only reached the stage of scanning paper records. The current systems are hugely inefficient and such inefficiency has a cost impact. An engine delivery or redelivery takes on average six to 10 days. However, this period can extend significantly. It is unfortunately normal to see disputes about missing parts and queries about technical data causing delays.

Disputes on inventory can be easily reduced through clear technical documentation and Recognition of Rights Agreements (ROHR) to ensure there is no misunderstanding about ownership of parts. Some aircraft lessors and owners willingly provide ROHRs, while others delay or do not provide them at all. It is important the industry standardizes ROHRs so that they can be executed speedily by the relevant parties.

On average, spare engines are utilized for less than 50% of their potential. A significant increase on this utilization level could lower lease rental costs for airlines. However, for the Zip-aero-engine business model to work, airlines will also need to comply with on-time

lease returns as otherwise the next user is affected.

Zipcar has created a community feel among its users, to the extent that users go to great efforts to ensure other users are not inconvenienced. Zipcar users typically leave cars in a tidy condition, whereas traditional car rental agencies find their assets used and abused so that they need to build car cleaning into the return process.

It is likely that we will first see Zip-aero-engine innovation on narrowbody engine types, such as the V2500-A5 and CFM56, because of the large number of potential users, the lower cost of assets and ease of transportation between users. Widebody engines are more difficult to transport, and airlines have a different risk appetite when it comes to sourcing spare engines because the costs of grounding a large aircraft are significantly higher.

The service providers that have close partnership relationships with customers will be in the best position to introduce new service innovations to the market as they can better understand the customers' needs and work closely with them to refine the services.

The zip-aero-engine business is not here yet but customers will benefit from this model in the future.

ENGINE VALUES 2014

A simple guide to engine values

Stuart Rubin
Principal
ICF SH&E

Compared to purchasing a new commercial aircraft, commercial jet engines have a lower capital cost, are more easily transitioned between operators and are often more liquid assets than the host aircraft, making spare engines an asset class of interest to many investors.

Further, interest in engines from aircraft lessors increases as an asset ages, given that the proportion of asset value attributable to the engines increases from about 25% in a new aircraft to 90% or more in an engine approaching its end of life. Indeed, some industry participants casually refer to airframes of end- of- life aircraft as "engine stands".

Engine residual values and their careful management are consequently of high importance both to operators and investors.

Multiple factors drive engine value behaviour, including maintenance costs, fuel burn, ease of remarketing, forecast demand for the associated aircraft and aircraft expected useful life. In general, as an aircraft reaches the latter stages of its operational life, the engines comprise a much greater percentage of total asset value. As a result, investors and airlines pay close attention to residual values of their engines.

Engine value behaviour and trends

Aircraft engines may be categorized by the maximum amount of thrust they produce and, all else being equal, the values of new engines are strongly related to this parameter. Used engine values are, however, related to asset-specific considerations, together with general supply and demand for the engine model.

Asset-specific considerations

Throughout its life cycle the value of an individual engine varies significantly based on its specific maintenance condition: principally the condition of the life- limited parts in the engine and the time the engine can be expected to operate before requiring performance restoration. Other factors such as open mandatory compliance maintenance tasks, the presence of Parts Manufacturer Approval (PMA) parts or Designated Engineering Representative (DER) repairs in engines may impact values as well.

As seen in chart two, the value of a run-out engine can range from 10% to 50% of the value of a full-life engine.

General value trends over engine life cycle

The general value trends for engines can be characterized over three phases of the asset life cycle.

Phase one of the life cycle is characterized by continued strong new engine demand with used engine values increasing slightly faster than the rate of inflation in accordance with engine manufacturer escalation rates for new engines and spare parts. During this phase spare engine supply is tight because original equipment manufacturer (OEM) production capacity is focused on supplying engines for new airframes.

As demand for the platform aircraft begins to wane and the tempo of orders and deliveries begins to ebb, the engine enters the second phase of the life cycle. This phase is characterized by a period of stable supply and demand, and the slight depreciation of engine value is more or less offset by inflation. Engines in this phase of the value cycle tend to hold their value well.

The third and final phase of the engine value cycle is represented by changes in demand for the aircraft that the engine supports. As demand falls because of the nearing obsolescence of the host aircraft type – whether from stricter regulatory standards, market references or the entry into service of new products – the engine enters the third and final phase of the value cycle. Characterized by rapid changes in prices, engines begin to lose value quickly. Eventually, it becomes more economical to disassemble the engine into parts than to undertake costly overhauls. Engine values in this phase may be extremely volatile, as the supply of engines may fluctuate depending on part- out levels.

Dynamics driving values in engine market

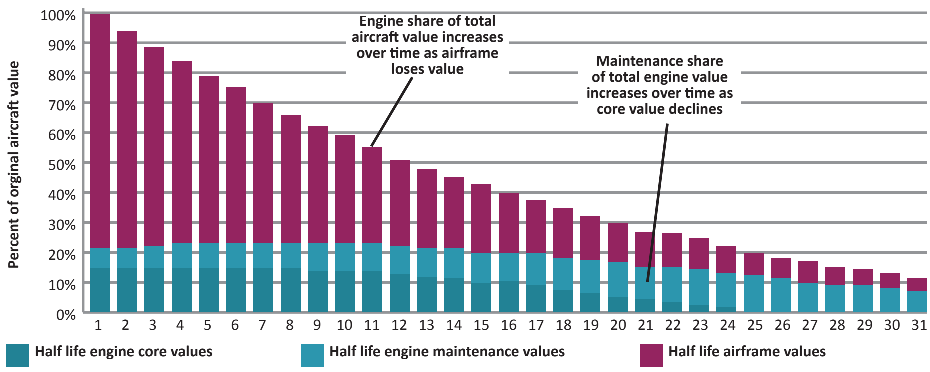
Multiple factors drive engine residual value behaviour, including market dynamics, evolving engine technology, OEM aircraft production rates, financing availability and market mass. Of additional consideration is the increasing presence of engine OEMs in the engines services sector through the use of Fleet Hour Agreements (FHAs), independent maintenance, repair and overhaul marginalization and reduced engine trading and spare parts provisioning opportunities, particularly on single engine choice aircraft types.

The rapid rise in jet fuel prices that started a decade ago has had a significant impact on the commercial airline industry. Prices for jet fuel have remained in the $3 a gallon range and show little sign of abating.

Between 2001 and 2008 fuel surpassed labour as the number one airline operating cost, and now comprises one-third of total airline operating expenses for International Air Transport Association carriers. This sustained high fuel price environment resulted in older-generation aircraft such as the MD-80 and 737 Classics – with their less fuel-efficient JT8D-200- and CFM56-3-series engines and higher operating costs – becoming marginalized as airlines moved to reduce fuel consumption. Many of these aircraft were removed from service in favour of current-technology A320- and 737NG-family aircraft, which offered better economics with their newer-generation CFM56-5B/7B and V2500-A5 engines.

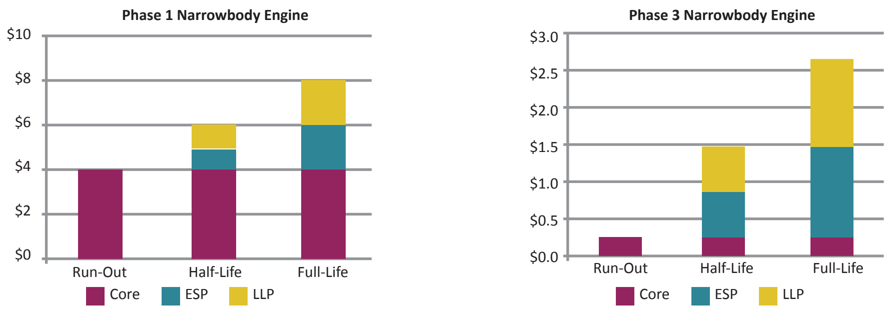
In conjunction with the replacement of older-

Chart One - Indicative schematic of aircraft residual values (airframe v engines)



> "Residual values for current-production engines – those in the first phase of the engine life cycle – continue to be strong especially for engines that are sole sourced on an airframe".

Chart Two - Indicative values of aircraft engines (values v condition)



generation aircraft with current types, airlines sought relief in the form of new aircraft programmes from the OEMs. Responding to demands for step changes in efficiency of 15% to 20%, in the mid-2000s, the OEMs began developing new generations of aircraft such as the 787 and A350, as well as re-engined versions of existing products such as the A320, 737NG and A330. While some of the efficiency gains stem from the use of weight-saving materials and an improved construction process for the airframe, the majority of the advancements are expected to come from improvements in engine technology offering reduced fuel consumption.

As engine technology has improved fuel consumption has not only been reduced but also on-wing time before the first shop visit has generally increased – in some cases substantially. It is not unheard of for a first run CFM56-7B to operate in excess of 30,000 hours – equivalent to more than eight years of operation before the first anticipated performance restoration is required.

As Airbus and Boeing have steadily increased production rates on both their single- and twin-aisle product lines, engine OEMs have had to increase their production levels to meet this demand. OEMs must carefully manage their production of spare engines for stability of used engines in the aftermarket.

The availability of financing and rates at which engines are financed also has an impact on the engine marketplace. Engines that are in the second or third phase of the life cycle can be challenging to finance, at least with less desirable rates and terms. Older technology engines in the third phase of their lives may be particularly challenging given volatility in values that can occur in the markets.

Of further note in the engine market is the market mass of the engine, which is the ratio of the number of engines in service to the number of operators. Engines supporting large fleets with broad operator bases – thus allowing for increased opportunities to place spare engines into the market – such as the CFM56-5B and the CF6-80C2 series should experience relatively improved demand and stronger pricing levels than those which are more concentrated.

The subject of term-based engine OEM Fleet Hour Agreements has generated much industry and investor discussion and has become of vital importance when discussing engine residual values. These FHAs, while quite beneficial to the operators by providing a more seamless solution to managing engine maintenance, have become a serious challenge for asset owners, particularly of mature engines. Near the end of the life of an engine its value is comprised of any green-time value, the value of the maintenance that may still be consumed before requiring repair, together with the part-out value of the engine after the green-time is consumed.

Dominating positions in the aftermarket by some OEMs has effectively meant that, for some engine types, effectively no secondary parts market exists, such that the price for the engines is effectively set by the single OEM buyer, which has not supported values well. Careful consideration and underwriting is required for investors in engines with these market dynamics, particularly in relation to potential lessee default, programme transferability between lessees and the maintenance costs of mid- and end-of-life engines.

Engine residual values – winners and losers

So what is the outlook for engine residual values given today's market environment? Like many things in the business world it still comes down to some key fundamentals.

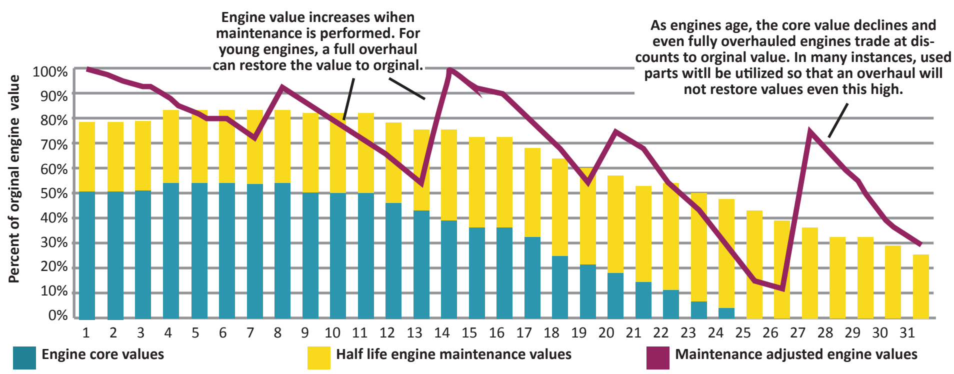
Residual values for current-production engines – those in the first phase of the engine life cycle – continue to be strong, with engines that are sole sourced on an airframe, such as the CFM56-7B and GE90-115B, exhibiting good residual value retention, with values slowly increasing. These engines should have long lives because the fleets of the host aircraft are large with significant operator bases.

Although replacement technology aircraft and engines are scheduled to enter service in the medium term, there has been no impact on engine residual values because it will take some time for the replacement technology aircraft to enter the fleet in numbers large enough to displace existing types.

Conversely, values for what were until recently considered phase two engines have declined substantially, as many examples of the host aircraft have left the fleet, such as the CFM56-3 and CFM56-5C experiencing significant softening.

As aircraft mature and edge closer to the end of their economic lives, owners and investors must keep a close eye on market dynamics and other factors that have an impact on engine residuals. Those that manage the cycle effectively will be in the best position to extract as much value as possible throughout the engine's life.

Chart Three - Indicative schematic of engine residual values



SPONSORED EDITORIAL

Engine Investors: Have you been caught with your pants down?

By Steven Taylor, senior vice-president, sales and marketing, TES Aviation Group.

Steven Taylor
SENIOR VICE- PRESIDENT
SALES AND MARKETING
TES AVIATION

The only way really to reduce the financial burden for engine ownership is not to buy any. But for those who do want to invest in these engineering feats of beauty, there are some tips to help minimize costly mistakes.

TES Aviation Group manages more than 800 engines valued at about $2 billion for airlines and lessors. From this experience I would like to share some insights on current engine trends and the issues that keep our customers up at night to help other investors.

Some recent trends

Current-generation engines have a significant EIS uptake on flight-hour agreements, largely at point of aircraft sale, compared with previous-generation engines. Flight-hour agreements, called a variation of names by original equipment manufacturers (OEM) and maintenance, repair and overhaul (MRO) providers, have been around for some time, and take many forms.

These programmes attract operators by offering predictability of cost and expert engineering back up, allowing them to focus on their core business of flying. They are, for the OEMs, a vehicle that offers a guaranteed revenue stream through which they can offset certain research and development costs and concessions made at point of aircraft sale.

How has this happened? What roles have investors and lessors played in this trend and why are airlines so keen to relinquish control of the arguably lesser cost of effectively managed time and material (T&M) programmes. These are questions to which I'm sure many of us have our personal views on.

OEMs are charging ahead securing the new engine maintenance programmes, but they are not stopping there. The so-called sunset engine aftermarket is viewed as highly complex given its correlation with volatile market conditions.

OEMs have for some time allowed many independent MROs to service this mature market without much interjection. However, with introductions of programmes such as true engine status, influencing parts and total care flex it is clear the OEMs want a share of the end-of-life market. This is driven by a need for additional revenue, or perhaps to increase a stronghold on brand adoption. Or it could be a response to tougher competition from the other OEMs.

Fewer and fewer lessors are taking speculative orders on new aircraft for two main reasons. First, in efforts to mitigate risks, they strive for guaranteed outlets. Second, balancing complex funding against variable customer demand, they need access to new aircraft in much shorter timeframes to capitalize on opportunities. Sale/leasebacks seem to provide the answer. For airlines, it provides the new equipment needed for strategic fleet upgrades while supporting a healthier balance sheet on what is already a very skinny bottom line.

Recently there have been several joint ventures agreed between engine lessors and MROs, including MTU/Sumitomo and ADAT/Sanad. The lessors' strong relationships with MROs and their conjoined interests have driven these joint ventures.

Nordic Aviation is a good example. Its operator base is largely low credit airlines which are high risk. To ensure asset value retention, the lessor controls the maintenance programme, for some customers, through long-tern service agreements (LTSAs) direct with the MROs. ILFC offers an integrated lease solution, inclusive of maintenance control, through its Lease Enhancement Programme product to reduce the lease phase in/out issues. Lessors want more and more control of what goes on with their asset.

Airline concerns

TES recently provided the chief financial officer of an operator a projected five-year maintenance cost budget for one of its engine fleets for the first time. On seeing the

“Get someone dedicated to manage each shop visit. Do not leave it up to someone else. Remember, if you do not do it, someone else will, and you may not like how they do it.”

US dollar value presented on the screen, he quickly assembled the ranks to question first why he has not seen this before, and second to discuss and agree a plan to decrease the cost.

Chief financial officers are increasingly more interested to learn of these fancy rotating bits of metal, given the significant impact they have on the airline’s financial viability. This particular airline also owned the engines, so it had a vested interest in the asset value, and needed a plan to exit the equipment at the optimum time to maximize value and minimize investment on the ageing fleet. Airlines are therefore concerned about both the day-to-day profit and long-term profitability.

Lessors will always be concerned with asset value retention. There are high yields achievable during the asset lifecycle, driving the increase of investors into the midlife engine market but there are also high risks. Lessors have typically allowed for quiet enjoyment clauses within their contracts, as a means of ensuring the asset owners do not dictate removals at the detriment of the airline’s operations.

This means, in practice, airlines take the engine from lessors in x condition, and give it back to lessors in y condition, whatever they do in the interim period is for them to decide. Lessors have been anxious about the impact the lessee operation and maintenance programmes have on their asset value, and are more concerned with the long-term profitability of the asset. We are now seeing the lessors take an active concern in the day-to-day profit of their engines through management of the maintenance programmes themselves.

Engines lasting longer on wing is a good thing, right? The answer is, of course, yes. However, new-technology engines such as the Leap, PW1000G, GE9X, Trent XWB are increasing in efficiency design after design.

Although OEMs provide marketing data for expected time on wing, they cannot know how the engine will perform in real operating life. This has been demonstrated with a CFM56-7B engine flying past 50,000 hours before its first maintenance event. This was much longer than what was initially planned. Airlines and lessors need to plan, and having these unknowns will make it a challenge to do so.

The more the OEMs tighten the leash on repair licencing and the greater the complexity of technological advancements the less ability independent MROs have to compete. Airlines cherish choice, and understand a competitive maintenance supplier environment drives better pricing. If competition diminishes, what will happen to pricing?

Key considerations

What can be done? Let us consider the life cycle of engine ownership and review some key considerations.

Buy well:

When a candidate engine is identified, ensure you know every dirty little secret that engine has to reveal – you will after all be taking on all its baggage. Invest at the beginning, to ensure you are protected at the end. Forecast your liabilities based on previous history, before you close the deal.

We all know the importance of buying at the right price. When we consider the risks as an investor, what you pay must be highly ranked. The more data points used in the analysis, the better the confidence in the number concluded. If you can assign value at component level for the whole engine, it will invariably differ from what the market has assigned. However, having a good understanding of what you can exit through material sales from bottom-up calculations will help you understand the risks against what you are being asked to pay by market conditions.

Manage well:

Once you have added the engine to your fleet, it is your responsibility to look after it. If you do not, someone else will, and you may not like how they do it. There are many other parties which also have an influence in the care of your engine.

The OEMs often issue hardware standard upgrades based on new technology or repairs. These upgrades could render high value components you have factored during your buying analysis worthless. Keep a close eye on all service bulletins, technical document reviews, airworthiness directives and all other technical documentation issued by the OEMs to ensure you can proactively manage their impact.

Having the right tools in place can provide understanding of what each change translates into for time on wing expectations and cost.

Ensure you have a robust system, process and team to manage the review of technical documentation issued by the OEM. Seek to understand what (if any) impact each will have on your asset. Run a return on investment analysis for each one to determine their incorporation or not. Be proactive. Technical really does translate into dollars, and if you get it wrong it can translate into many dollars lost.

If you do not have someone dedicated to managing each individual shop visit event, then do so. If you do not have someone carefully writing each workscope, or overviewing in the case of lessors, then do so. If you do not have someone visiting each table inspection, scrap review or running a thorough invoice review then >>>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TURBOPROP ENGINES

Turboprop engines seek meaningful relationship

Avic's MA700 turboprop took a step forward at the Farnborough Airshow, but the wait goes on for the launch of a large turboprop for which engine manufacturers say they are ready. Geoff Hearn reports.

Engine manufacturer Pratt & Whitney Canada and Chinese aircraft company Avic announced at the Farnborough Airshow in July that the PW150C engine will power the Chinese manufacturer's new MA700 regional turboprop. Both companies say this a major milestone for the recently launched aircraft.

While the the deal is arguably a coup for Pratt & Whitney, it hardly heralds a new era in the manufacturing of turboprop engines. Even the company's press release emphasizes the engine's history rather than focusing on any new technologies it offers.

John Saabas, president, Pratt & Whitney Canada, is quoted as saying: "This engine selection comes as the PW100/PW150 is celebrating its 30 years of leadership in the regional turboprop segment this year and further underscores its reputation as the engine of choice of aircraft manufacturers."

The announcement also does little to clarify the likelihood of a larger turboprop aircraft being launched, a possibility that is the source of much industry speculation.

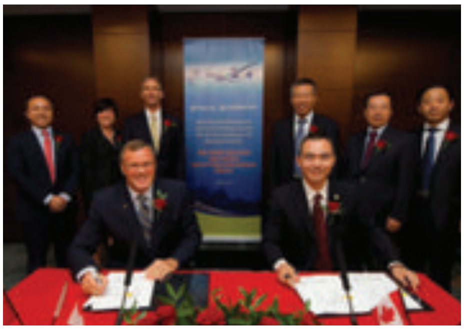
Pratt & Whitney has been the dominant supplier of engines for commercial turboprops for decades and, as the incumbent manufacturer on both the ATR 72 and Bombardier Q400, is in pole position to provide a new engine for a larger turboprop in the 90-seat to 100-seat category.

The MA700 is planned to be slightly larger than the current ATR 72 and Q400, and entry into service is targeted for 2019.

Avic says it has plans to stretch and shrink the baseline 70-seat aircraft, so the engine-selection milestone may be a small step in the direction of a 90-seat turboprop. However, there is a long way to go before the manufacturer is in a position to deliver such an aircraft, particularly outside of its own domestic market.

The Chinese company has struggled in the past to meet target dates for the entry into service of new aircraft programmes, and obtaining certification of the base-line MA700 model for non-Chinese markets will be a difficult enough task. Given its track record, Avic will do well to compete with the current 70-seaters of ATR and Bombardier, and the introduction of a 90-seat model may be a step too far.

In any case, a stretch of the MA700 would probably require a new engine because the current PW150 family has a maximum rating of just over 5,000 shaft horse power (SHP) and is unlikely to be able to provide sufficient power for a 90-seat model.



John Saabas, president, Pratt & Whitney Canada and Wang Chengkuan, director and general manager, Avic, sign the agreement that the PW150C will power the MA700 regional turboprop.

Bombardier and ATR have said they will only launch programmes if a suitable new engine is available with increased power and significantly improved fuel efficiency compared with the models installed on the current generation of aircraft.

Power supply

The engine manufacturers are bullish about the prospects of a turboprop in the 90-seat to 100-seat category, and are vying to provide the power for such an aircraft when and if it is launched.

Pratt & Whitney Canada has indicated it is designing a new 5,000SHP to 7,000SHP engine for a larger turboprop, and the company has previously told *Airfinance Journal* that there are several operators which would launch services with a 90-seater if it existed.

The Canadian manufacturer's developments are believed to include advanced cooling and a compact compressor with a fully integrated propeller system. The new developments would be part of the specification for what the company calls its NGRT (next-generation regional turboprop) programme. It says testing has been successful and "results are on target". Discussions continue with airframe manufacturers about potential applications.

General Electric (GE) says its market forecast for the 61- to 90-seat turboprop market is in line with other industry studies, predicting that 2,600 to 3,000 aircraft will be required

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“ATR has carried out studies for an all-new aircraft with a five-abreast seating layout – indicating that a further stretch of the ATR 72 was not viable.”

in the next 20 years. How many of these will be in the 90-seat category is a matter of conjecture, according to the company, because it is difficult to split the market segment further with any degree of accuracy.

The next-generation engine that GE is working on to meet this market demand is designated the CPX38. The turboprop is based on the GE38 turboshaft engine that will power the Sikorsky CH-53K helicopter. The GE38 has already undergone extensive testing, and indications are that the technology is available to develop an engine that will offer about 15% savings in fuel burn compared with current-technology turboprops.

GE says that, as for the new generation of engines for single-aisle aircraft, savings will come from advances in areas such as increased pressure ratios, turbomachinery aerodynamic efficiencies, cooling design improvements and new materials. Further efficiencies will come from an integrated propeller, engine and nacelle design, which provides scope for savings from advances in installation efficiencies.

In addition to the two incumbent manufacturers, French aviation group Safran may enter the market sector. Two engine makers from the group, Snecma and Turbomeca, have revealed a joint study of a potential new powerplant for the turboprop market. The study engine, outlined in a presentation by Pierre Fabre, Snecma's chairman and chief executive officer, is targeted at a power range up to about 5,000SHP, which is far larger than any previous turboprop made by Turbomeca. Fabre believes a continued rise in oil prices will reverse the trend to regional jets seen in the 1990s and that there will be a resurgence in the turboprop market.

Fabre sees potential for more new large turboprops in China, India and Russia, and believes this could lead to new industrial links. Snecma has experience of such links as part of the PowerJet joint venture, which provides the engines for the Russian-built Sukhoi SSJ regional jet.

To launch or not to launch

There is little doubt that over the past few years the market for commercial turboprop aircraft has revived. However, despite this resurgence in fortune, the sector remains relatively small. If the forecasts of a requirement for about 3,000 aircraft in the category are correct, the 20-year market could be worth close to $100 billion. Although this seems a large number, it is dwarfed by the sectors that Boeing and Airbus cover, which are likely to generate more than $4 trillion in the same period.

Nonetheless, there is significant interest in the 90-seat to 100-seat turboprop category, a segment where there is currently no offering, and most industry commentators had expected at least one of the potential manufacturers to take the plunge by now.

There are several projects muted by non-established civil aircraft manufacturers (see box), but Bombardier and ATR are clearly the most likely contenders. Given Bombardier's investment of resources in the CSeries and the trials and tribulations it is having with that aircraft, its reluctance to launch another new programme is not surprising.

ATR's recent run of good results had increased speculation that it would take a decision to go ahead, but the tone of the manufacturer has changed despite continuing good results. (The company announced at the beginning of the Farnborough show that it had already taken firm orders for 144 aircraft in 2014, which is already a 50% increase over the total sales for the previous record year of 2013).

The European manufacturer has carried out studies for an all-new aircraft with a five-abreast seating layout – indicating that a further stretch of the ATR 72 was not viable. The main areas of concern for ATR had previously been whether the technology (particularly for the engines) was available to allow an adequate improvement in fuel efficiency, and whether there was a sufficiently large market to warrant the investment that an all-new aircraft would require.

A company representative told *Airfinance Journal* that the main question is one of resources, in part caused by the success of the existing programmes and the need to support and improve them. ATR has ambitious plans to increase its current production rate of 80 aircraft a year to 95 next year and to 100 in 2015.

It is no secret that Finmeccanica, 50% owner of ATR, is much keener on a launch than EADS, which holds the other 50% of the manufacturer's shares. It is clear that for the time being it is the EADS view that is likely to prevail.

Given the most likely candidate is not going to launch a larger turboprop in the immediate future, it looks as though the engine manufacturers will have to wait in their search for partners.

ASIAN MANUFACTURERS EYE TURBOPROP MARKET

The potential market for large turboprops, much of which is likely to come from Asia, is attracting the attention of manufacturers in countries in the region with relatively little experience in the commercial aircraft market.

A number of Asian countries are looking at the sector with a view to entering, or increasing penetration of, the commercial aircraft market, but the proposals vary in timing and probability of launching.

Chinese manufacturer Avic's MA700 (see main feature) is due to go into service in 2019 and, despite doubts about the company's track record on keeping to schedules, it is by far the most concrete programme. A stretched version, the exact size of which is not yet defined, will almost certainly not be available before the mid-2020s.

India's Regional Transport Aircraft (RTA) is a project that would involve Hindustan Aeronautics and the country's National Aerospace Laboratories. Hindustan Aeronautics said at the Farnborough Airshow that a request for proposal will soon be issued for choosing an engine for the RTA. The initial aircraft would be a 70-seater with the potential for a stretch and, according to a statement issued at the air show: “The aircraft would be manufactured in India with an expected roll-out by 2022.”

Another potential programme could emerge from Korea Aerospace Industries' discussions with Bombardier regarding participation as a partner on the Q400 stretch. Talks with the Canadian manufacturer petered out, but details of an indigenous South Korean design have subsequently been published and include the participation of Korean Air.

AIRCRAFT ENGINE OPTIONS 2014

ENGINE TYPES

Aircraft	Engine options
A300B4-200	GE: CF6-50C2, CF6-50C2R
A300B4-200F	GE: CF6-50C2
A300-600R	GE: CF6-80C2A5, P&W: PW4158
A310-300	GE: CF6-80C2A2, CF6-80C2A8, P&W: JT9D-7R4E1, PW4152, PW4156A
A318-100	CFM: CFM56-5B8, CF56-5B9, P&W: PW6122. PW6124
A319-100	CFM: CFM56-5A4, CFM56-5A5, CFM56-5B5, CFM56-5B6, CFM-5B7, IAE: V2522, V2524, V2527
A320-200	CFM: CFM56-5A1, CFM56-5A3, CFM56-5B4, CFM56-5B6, IAE: V2500-A1, V2527
A321-100	CFM: CFM56-5B1, CFM56-5B2, IAE: V2530
A321-200	CFM: CFM56-5B1, CFM56-5B2, CFM56-5B3, IAE: V2530, V2533
A330-200	GE: CF6-80E1A2, CF-80E1A3, CF-80E1A4, P&W: PW4168A, RR: Trent 772B-60
A330-200F	P&W: PW4170, RR: Trent772B-60
A340-200	CFM: CF56-5C2, CF56-5C2\F, CF56-5C2\G, CF56-5C3\F, CF56-5C4
A340-300	CFM: CF56-5C\P, CF56-5C2, CF56-5C2\G, CF56-5C2\F, CF56-5C3\F, CF56-5C4
A340-500	RR: Trent 553
A340-600	RR: Trent 556-61
A380-800	GE: GP7270, RR: Trent 970-84, Trent 972-84
717-200	RR: BR715A1-30, BR715C1-30
737-200	P&W: JTD8-7B, JTD8-9, JTD8-9A, JTD8-15, JTD8-15A, JTD8-17, JTD8-17A
737-300	CFM: CFM56-3B1, CFM56-3B2, CFM56-3C1
737-400	CFM: CFM56-3B1, CFM56-3B2, CFM56-3C1
737-500	CFM: CFM56-3B1, CFM56-3B2, CFM56-3C1
737-600	CFM: CFM56-7B20, CFM56-7B22
737-700	CFM: CFM56-7B20, CFM56-7B22, CFM56-7B24, CFM56-7B24\2, CFM56-7B26
737-800	CFM: CFM56-7B24, CFM56-7B26, CFM56-7B27
737-900	CFM: CFM56-7B24, CFM56-7B26
737-900ER	CFM: CFM56-7B27
747-200 Combi	GE: CF6-50E2, CF6-80C2B1, P&W: JT9D-7FR4G2, RB211-524C2, RB211-2524D4
747-200F	GE: CF6-50E2, RR: RB211-524C2, RB211-524D4, P&W: JT8D-70A, JT8D-7A, JT8D-7AW, JT8D-7F,
747-300	GE: CF6-50E2, CF6-80C2B1, P&W: JT9D-7R4G2, RR: RB211-524C2, RB211-524D4
747-400	GE: CF6-80C2B1F, CF6-80C2B5F, P&W: PW4056, RR: RB211-524G, RB211-524GHT, RB211-524H, RB211524H2, RB211-524HT
747-400 Combi	GE: CF6-80C2B1F, P&W: PW4056
747-400F	GE: CF6-80C2B1F, P&W: PW4056, RR: RB211-524/G\H-T, RB211-524H2
747-400BCF	GE: CF6-80C2B1F, P&W: PW4056
747-400ER	GE: CF6-80C2B, P&W: PW4062
757-200	P&W: PW2037, PW2040, RR: RB211-535C, RB211-535E4, RB211-535E4-B
757-300	RR: RB211-535E4-B, RB211-535E4-C, P&W: PW2043
767-200ER	GE: CF6-80A2, CF6-80C2, CF6-80C2B2, CF6-80C2B2F, CF6-80C2B4, CF6-8w0C2B4F, CF6-80C2B4FA, CF6-80C2B6F, P&W: JT9D-7R4D, JT9D-7R4E, JT9D-7R4E4 P&W: PW4052, PW4056, PW4060
767-300	GE: CF6-80A2, CF6-80C2B2, CF6-80C2B2F, CF6-80C2B4F, P&W: PW4056, PW4060, JT9D-7R4D
767-300ER	GE: CF6-80C2B2, CF6-80C2B2F, CF6-80C2B4, CF6-80C2B4F, CF6-80C2B6, CF6-80C2B6F, CF6-80C2B7, CF6-80C2B7F, P&W: PW4056, PW4060, PW4062, RR: RB211-524H
767-400ER	GE: CF8-80C2B7F, CF8-80C2B8F
777-200	GE: GE90-90B, P&W: PW4077, PW4084, RR: Trent 875-17, Trent 884
777-200ER	GE: GE90-90B, GE90-92B, GE90-94B, P&W: PW4084D, PW4090, RR: Trent 890B, Trent 892, Trent 892B, Trent 892B\2, Trent 895
777-200LR	GE: GE90-110B
777-300	RR: Trent 892, Trent 892-17, Trent 892B, P&W: PW4090, PW4098
777-300ER	GE: GE90-115B
777F	GE: GE90-110B1L
747-8	GE: GEnx-2B67
787-8	GE: GEnx, RR: Trent 1000

Source: Avitas's Blue Book of Jet Aircraft Values

N.B. All aircraft have 20 or more aircraft still in service.

AIRCRAFT ENGINE VALUES 2014

Engine	Fair market value ($m)	Base Value ($m) $	Monthly rental ($000)	QEC cost range ($m)	LLP Cost (new) ($m)	Overhaul (ex LLP) ($)	MTBO	FH:FC (hours)
CFM International								
CFM56-3C1 (23.5)	1.25	1.50	20 - 35	0.25 - 0.20	2.50	1.35	7,000	1.6
CFM56-5B3/P	6.37	6.77	60 - 80	0.89 - 2.40	2.80	2.70	13,000	1.8
CFM56-5B4/3	6.70	6.84	60 - 80	0.89 - 2.40	2.80	2.70	19,000	1.8
CFM56-5B6/P	4.77	4.97	60 - 80	0.89 - 2.40	2.80	2.70	19,500	1.8
CFM56-5B5/3	5.00	5.12	60 - 80	0.89 - 2.40	2.80	2.70	21,000	1.8
CFM56-5C4/P	4.31	4.80	45 - 60	0.60 - 1.20	2.90	2.55	15,000	6.0
CFM56-7B20	4.27	4.37	45 - 70	0.40 - 1.50	2.70	2.80	22,000	1.8
CFM56-7B22	4.72	4.82	45 - 70	0.40 - 1.50	2.70	2.80	18,000	1.8
CFM56-7B24	5.52	5.62	45 - 70	0.40 - 1.50	2.70	2.80	17,000	1.8
CFM56-7B26/3	6.67	6.72	64 - 83	0.40 - 1.50	2.70	2.80	17,000	1.8
CFM56-7B27/3	6.97	4.70	64 - 83	0.40 - 1.50	2.70	2.80	16,000	1.8
General Electric								
CF34-3B1	1.28	1.70	20 - 30	0.19 - 0.80	1.50	0.90	12,000	1.3
CF34-8E5	3.32	3.32	35 - 43	0.50 - 0.90	2.30	1.13	11,000	1.3
CF34-10E6	5.09	5.09	53 - 78	0.80 - 1.60	1.95	1.45	16,000	1.3
CF6-80C2B6F	4.50	4.90	45 - 65	0.30 - 0.80	6.00	2.68	15,000	6.0
CF6-80E1A3	10.18	10.18	90 - 125	1.20 - 2.50	8.60	3.70	18,000	5.0
GE90-115BL	24.10	24.10	190 - 280	0.70 - 2.10	10.15	8.00	18,960	6.5
International Aero Engines								
V2522-A5	4.21	4.26	50 - 80	1.00 - 2.50	3.00	2.90	21,000	2.0
V2524-A5	4.71	4.76	50 - 80	1.00 - 2.50	3.00	2.90	19,500	2.0
V2527-A5	5.42	5.71	50 - 80	1.00 - 2.50	3.00	2.90	16,400	2.0
V2533-A5	6.38	6.85	50 - 80	1.00 - 2.50	3.00	2.90	11,500	2.0
Pratt & Whitney								
JT8D-217C	0.55	0.55	8 - 20	0.08	1.80	2.00	9,500	1.5
PW2037	2.95	3.70	35 - 55	0.38 - 1.00	5.30	5.00	18,000	3.0
PW4060	4.40	5.00	50 - 70	0.30 - 1.80	5.70	5.00	18,000	6.0
PW4158	4.00	4.90	40 - 60	0.30 - 1.80	5.70	5.00	10,000	1.8
PW4168A	7.48	8.20	80 - 110	1.40 - 3.20	7.10	5.50	17,000	6.0
PW4090	10.50	10.50	115 - 160	1.00 - 2.50	11.70	11.50	18,000	7.0
Rolls-Royce								
AE3007A1	1.35	2.20	15 - 30	0.085 - 0.30	1.70	1.00	8,450	1.3
RB211-524H-T	2.68	4.00	15 - 40	0.13 - 0.90	5.20	5.00	22,000	8.0
RB211-535E4	3.05	3.80	30 - 45	0.23 - 0.90	4.20	4.50	19,000	2.4
Tay 650-15	1.50	1.50	20 - 30	0.15 - 2.80	1.00	1.70	11,000	1.1
Trent 772B	8.60	8.60	95 - 135	2.00	6.70	7.20	21,000	4.0
Trent 895	13.50	13.50	120 - 150	n/a	8.40	7.60	19,000	5.6
BR715A1-30	2.50	3.30	30 - 50	0.30 - 0.90	1.90	1.35	10,400	1.6


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To James, simply doing accounts doesn't add up.
When an airline customer needed an engine part to keep them flying, we discovered there wasn't a courier fast enough. That's when James, in our accounts team, took it upon himself to deliver it in person that day.
You see, the whole team understands what's important to our customers. We also know that if they succeed so will we. We call this partnership.
Partnership is our business.
Rolls-Royce & Partners Finance