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A SPECIAL SUPPLEMENT

Guide to financing and investing in engines 2015

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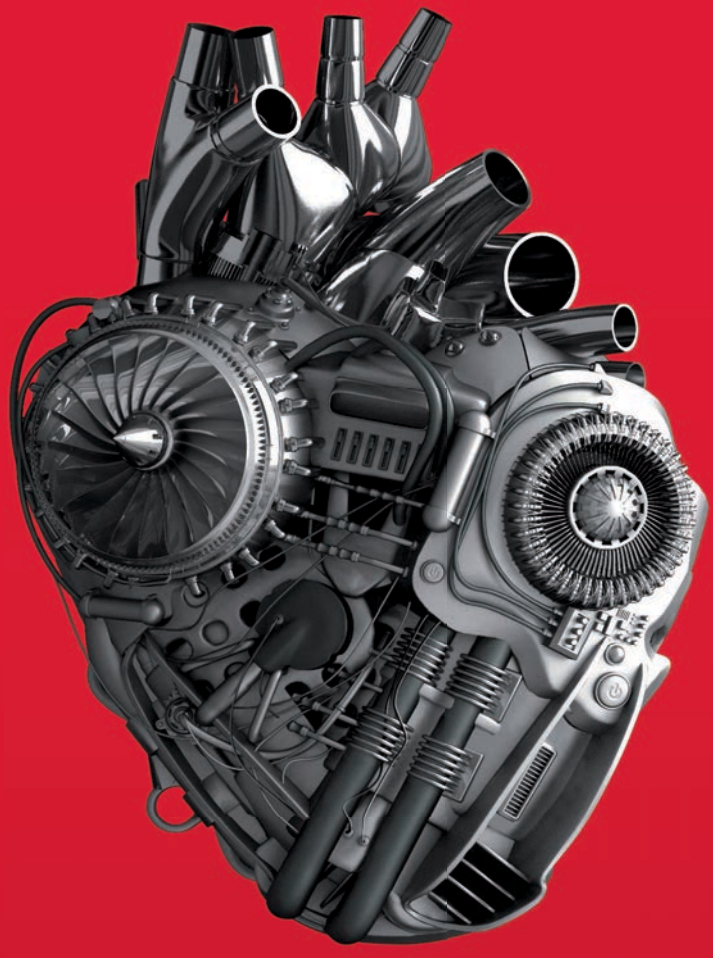

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Guide to Financing and Investing in Engines 2015

ENGINE SURVEY 2015 /12

Investor poll rewards new engines

Investors have recognized engines powering in-production narrowbodies, as well as new engine types in this year's engine survey. Joe Kavanagh reports.

Image credits: bisgovuk, cover and contents.

EDITOR'S LETTER

Rolls-Royce hints at evolving engine aftermarket service

The engine manufacturer says it is actively engaging the leasing community as it looks to adapt its TotalCare service offering for the Trent engine. Dickon Harris investigates.

Rolls-Royce states it is adapting its aftermarket service. The engine manufacturer has been the market pioneer with its TotalCare package – a fixed-cost engine maintenance contract for airlines which use Rolls-Royce engines.

Despite the success of the programme with airlines, the company is looking to adapt its maintenance programme principally to cater better to lessors which have become a growing, and vocal, owner of aircraft engines.

Lessors complain that because Rolls-Royce dominates the aftermarket for the Trent family of engines there is no natural parts market for engine investors looking to sell the aircraft. More than 90% of Trent engine maintenance is controlled by Rolls-Royce. Lessors state this reduces the residual values on the engine types, including the Trent 500, and worry it could affect the populous Trent 700 if the market does not open.

"The Trent 500 is not a liquid type. It is what Rolls-Royce will pay for it. If you are an investor you would be careful about buying certain types of planes, unless you can strike a good deal with Rolls-Royce," explains Olga Razzhivina, a director at aircraft appraisal firm Oriel.

Lessors state that TotalCare limits their control over their exposure to the potential workscope of the engine maintenance because Rolls-Royce collects the maintenance reserves for TotalCare directly from the airline. Lessors require flexibility because they need to transition engines between operators, or part-out the engine. Different airlines may have different maintenance packages with the manufacturer, which causes additional problems for the lessor. All these problems limit how much value the engine owner can extract from the assets.

Speaking to *Airfinance Journal*, Rolls-Royce states it recognizes there has been "negative market sentiment" directed towards the mature phase of the engine lifecycle, but adds it is "committed to further improvements to meet customer needs".

Since January the firm has begun conducting specific surveys for lessors as well as operators, and has "upskilled" its customer service team. But the Rolls-Royce team has also stated it is looking to go further and change the provisions of the TotalCare package itself.

"It is a question of segmenting your customers. Lessors are not the same as operators – hence, we need to understand their needs and respond to them differently," explains James Barry, senior vice-president, customer strategy and marketing, civil large engines at Rolls-Royce.

More than just the Flex

Last year the manufacturer stated it was adapting its package with a new model of its programme called TotalCare Flex aimed at helping lessors, and engine owners, extract value from the engine before it is finally parted out. The programme is still at a pilot stage but Rolls-Royce expects to "make more announcements on the Flex in quarter two", according to Barry.

"We have led and shown where greatest value can be given to customers and as the lifecycle advances we are leading again as the lifecycle shows different demands. Flex is one solution, not the solution, but one that addresses market requirements," adds Richard Goodhead, vice-president customer marketing, Rolls-Royce.

The manufacturer has already signed a contract with United Airlines to use elements of the TotalCare Flex programme to maintain the airline's RB211-535 engines operated by United on its Boeing 757 aircraft. Specifically, this means altering the workscopes on the engines for United.

"We will be changing workscopes to more closely align with a retirement profile. In the normal phase of life you would build a workscope that will continue for argument's sake six years. You can effectively overinvest in the asset and therefore may leave goodness in the engine, which you cannot extract or utilize. It is about how you change workscopes, how you build the engines to meet different profiles, whether it be different compositions of used materials, etc," adds Goodhead.

Rolls-Royce hints that it is examining other potential changes to its maintenance programmes. Lessors will hope this may mean a further opening up of the parts market, as the manufacturer previously did with the RB211 engine. The engine manufacturer is exploring ways of adapting its maintenance programmes for lessors and engine owners. Other engine manufacturers will be watching closely to see what the UK firm may offer.

Dickon Harris
Editor,
Airfinance Journal

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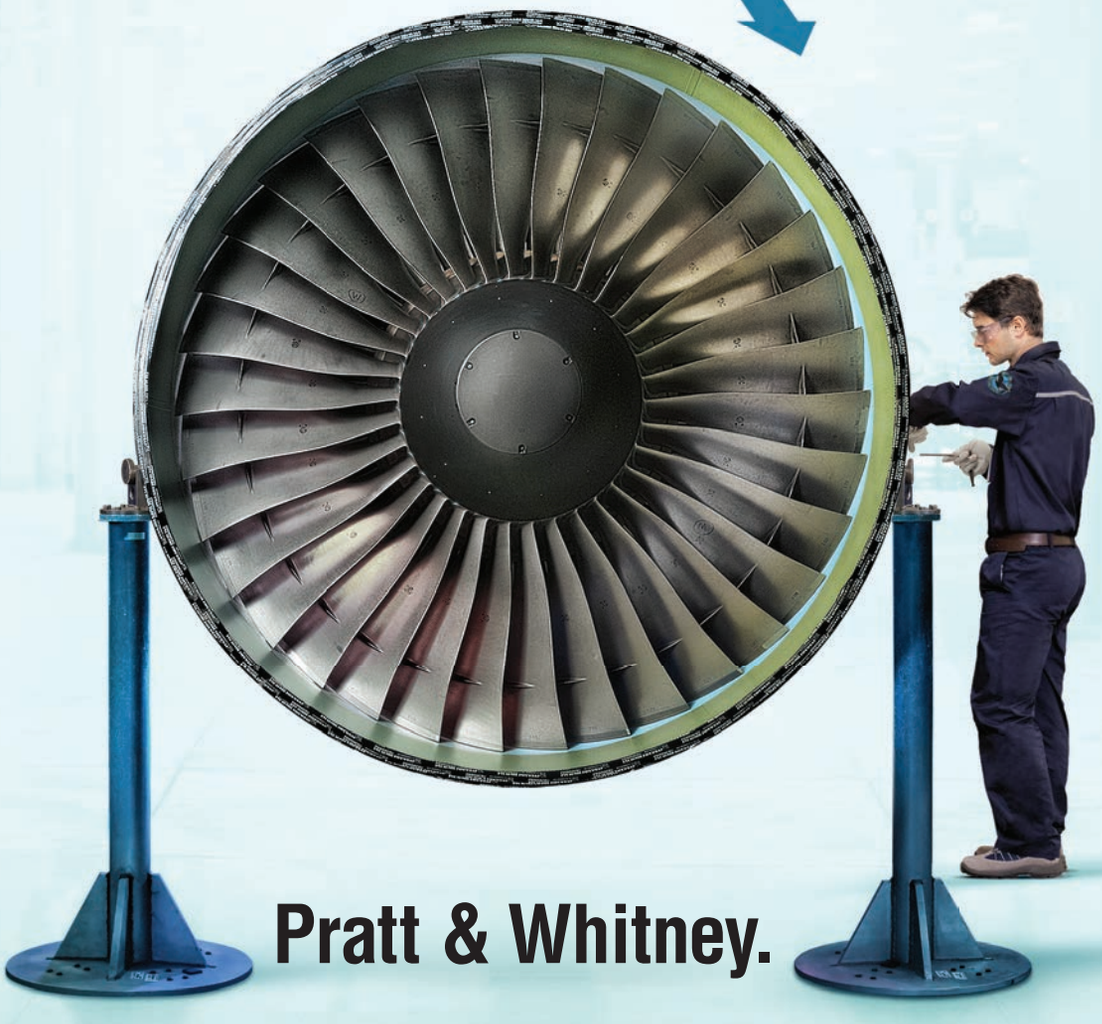

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NEWS

Engine News 2015

Rolls-Royce wins record A380 engine order from Emirates

Emirates has signed a $9.2 billion deal with engine manufacturer Rolls-Royce to supply engines for 50 A380s.

The Trent 900 engines, supported by a long-term TotalCare package, will be used to power 50 A380s the airline ordered in 2013.

Emirates' choice of Rolls-Royce is significant because the carrier's A380 engines have previously been provided by Engine Alliance, a 50-50 joint venture between General Electric and Pratt & Whitney.

A380s can be powered either by Trent 900s or Engine Alliance GP7000s.

Rishton retires from Rolls-Royce

John Rishton has retired as chief executive officer (CEO) of Rolls-Royce. He joined the manufacturer as CEO in 2011.

Rolls-Royce has appointed Warren East to replace him. East was CEO of ARM Holdings, a semi-conductor and software engineering company, from 2001 to 2013. He has been a non-executive director of Rolls-Royce since January 2014.

Omega Leasing closes $137m engine facility

Omega Leasing has closed a $136.5 million term loan to finance a pool of 14 Trent engines.

SMBC Leasing & Finance, DBS Bank and KfW Ipex-Bank acted as joint mandated lead arrangers and underwriters of the financing. SMBC Europe acted as facility agent and US Bank National Association acted as security agent.

The loan closed in April.

Omega Leasing is a joint venture between Rolls-Royce and GATX Corporation. The company also closed a $190 million term loan to finance 14 Trent engines in July 2011.

BOC Aviation orders V2500 engines

BOC Aviation has signed an agreement for firm orders of V2500 engines to power 12 new A320-family aircraft.

The aircraft are part of the Singapore-based lessor's existing order with Airbus.

The lessor recently reported a net profit of more than $300 million.

Kadam replaces Rao at Air India

Air India has appointed a new deputy general manager of engineering in its Mumbai office. DB Kadam is promoted to replace SM Rao, who retired on January 31 after 32 years at the company having started as a trainee engineer.

CFM names LEAP tooling suppliers

CFM International has granted licences to three tooling suppliers to support the advanced new LEAP engine. Customers will be able to purchase all LEAP line maintenance and overhaul shop tooling from AGSE, Dedienne Aerospace and Rhinestahl.

Under the terms of the licence, all suppliers provide identical coverage but the agreement is flexible enough to allow customers to split their orders between the three companies. AGSE, Dedienne Aerospace and Rhinestahl will all provide customer support, training, repair, warranty and documentation, and each will begin producing annual catalogues starting in 2016.

AerFin acquires 11 A340s from Cathay Pacific

Cathay Pacific Airways has agreed to sell 11 A340-300 aircraft powered by RB211-524 engines to maintenance, repair and overhaul provider AerFin.

The agreement will see AerFin acquire and/or consign the aircraft over a three-year period through to 2017. The first A340 was delivered in March, and will be parted-out.

Cathay Pacific is retiring the A340-300s as part of its ongoing fleet modernization programme.

First LEAP-powered A320neo rolls out of assembly

The first LEAP-1A-powered A320neo rolled out of the Airbus Toulouse assembly plant in April. The aircraft is scheduled for ground tests leading to its first flight.

CFM's new engine type took to the skies for the first time on October 6 2014 on a modified 747 flying testbed at GE Aviation Flight Test Operations in Victorville, California.

Bombardier flies first CS300 aircraft

In February Bombardier's CSeries aircraft programme reached a milestone with the maiden flight of the CS300 airliner.

Powered by Pratt & Whitney's PurePower PW1500G engine, the CS300 airliner departed Montréal–Mirabel International Airport at 11:00 EST and returned at 15:58 EST. In September 2014 Bombardier completed the maiden flight of the smaller CS100 model.

MRJ completes engine test

Mitsubishi Aircraft Corporation started full-scale testing of the Mitsubishi Regional Jet (MRJ) toward its first flight scheduled in the second quarter of this year.

Mitsubishi Aircraft performed the first engine run in January of the Pratt & Whitney PurePower PW1200G engine that powers the MRJ for its first flight test at the apron of the Nagoya Airport on January 13.

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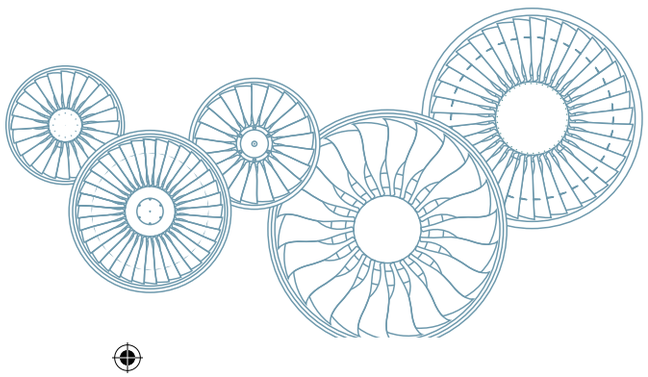

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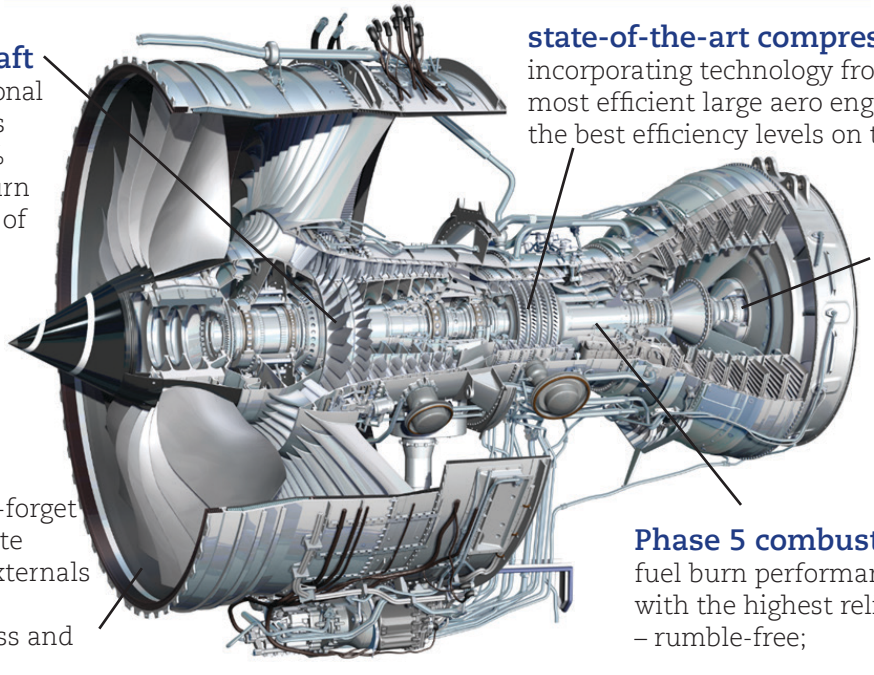
ENGINE COMPARISON

Trent 1000

unique three shaft design: no operational constraints, such as icing. Additional 1% through-life fuel burn advantage because of the superior performance retention.

state-of-the-art compression system: incorporating technology from the Trent XWB, the most efficient large aero engine flying today, delivering the best efficiency levels on the 787;



advanced HP turbine architecture with adaptive cooling: for high efficiency, best reliability and excellent durability even in harsh environmental conditions.

ENABLES: fit-and-forget innovative composite snap-on fan case externals for reduced weight, increased robustness and easy maintenance.

Phase 5 combustor: provides the best fuel burn performance on the 787 combined with the highest reliability and lowest noise – rumble-free;

What is the improvement in fuel burn of the engine over the equivalent current-generation models?
The Trent 1000 is 15% more fuel efficient than the engines it replaces. This has been achieved through the introduction of proven new technologies from demonstrator programmes and, in the case of the latest version of the Trent 1000, technologies from the world's most efficient large aero engine, the Trent XWB and the Advance engine programmes. These include an adaptive HP cooling system to improve cruise performance, the introduction of blisks for lower weight and modulated turbine clearance control for even better performance retention.

What do you believe are the key advantages of your engine versus the main competitor?
The latest version of the Trent 1000 has the final word in terms of delivering the best engine on the 787 Dreamliner. It has the best performance on the 787 on all the key parameters – economics, reliability and service support. It is also the quietest engine on the 787.

Fuel burn performance is up to 3% better than its competitor, while superior performance retention, through the engine's more robust three-shaft architecture, is worth a further 1% through life.

The Trent 1000 is also the most reliable engine on the aircraft, delivering the best entry-into-service performance for any widebody engine with average dispatch reliability since entry into service of 99.9%.

Its design means it is not susceptible to any operational restrictions because of icing at altitude – giving operators complete confidence in their scheduling and the economic advantage of not needing to carry extra fuel to cover an ice-related diversion.

This is why the Trent 1000 has been selected in 60% of competitions in the past five years.

How will the maintenance costs of the new-generation engines compare with their predecessors?
The excellent durability characteristics of the Trent 1000, particularly in harsh environmental conditions, including sandy, hot and contaminant-heavy environments, as well as in ice-crystal-forming weather conditions, mean that the maintenance burden is minimized. This is achieved via blending product attributes to balance performance and resilience.

The latest version of the Trent 1000 not only features the Trent family signature fan-case mounted accessories for ease of maintenance, but also uses the ENABLES system of modular composite rafts to mount these accessories to further minimize maintenance burden and costs.

Because of the common architecture across the Trent family, existing component repair techniques can be read across to the Trent 1000 to extend life on wing and minimize overhaul costs.

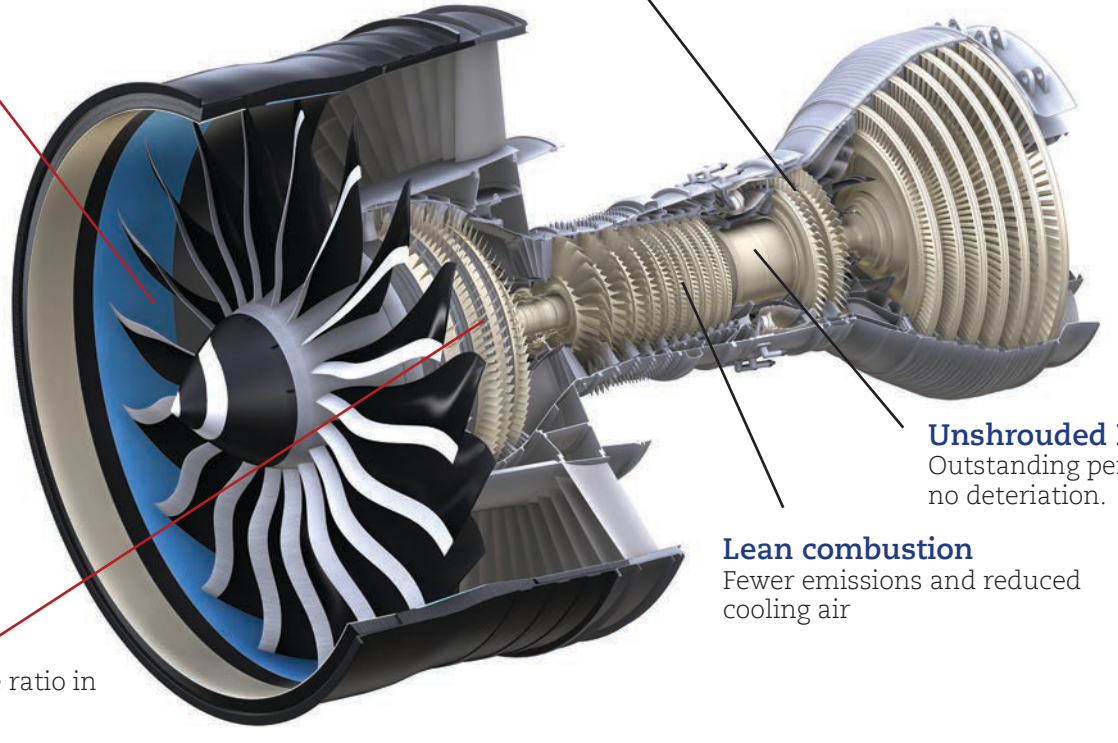
How competitive will the engine overhaul market be?
In addition to fully owned and controlled in-house overhaul facilities, Rolls-Royce engines may be overhauled with confidence at one of four joint venture facilities or eight repair facilities across the globe – none of which Rolls-Royce has a controlling stake in – ensuring the overhaul market remains as competitive as possible. The number of Trent maintenance, repair and overhaul-capable independent facilities continues to increase, offering further choice to customers.

ENGINE COMPARISON

GEnx

Composite fan
First composite fan case with thinner, stronger, fewer blades for 350 lbs weight savings and no line maintenance burden

TiAl
New material for weight savings and better fuel burn



Unshrouded HPT blades
Outstanding performace with no deteriation.

Lean combustion
Fewer emissions and reduced cooling air

Compressor
Highest pressure ratio in aviation

Tom Levin,
GENERAL MANAGER OF THE GENX PROGRAM
GE AVIATION

What is the improvement in fuel burn of the engine over the equivalent current-generation models?
The GEnx-1B engine is up to 15% more fuel efficiency than the CF6-80C2 engine that it replaces.

What do you believe are the key advantages of your engine versus the main competitor?
The GEnx-1B engine has several key advantages compared to the competition. The engine has a more than 2% fuel burn advantage over the competition, and GE believes it has a 1% advantage in performance retention for a 3% advantage. The engine will also stay on wing about 40% longer than its competitor. This means reduced maintenance costs for operators.

How will the maintenance costs of the new-generation engines compare with their predecessors?
The engine will stay on wing longer than its competitor. This means reduced maintenance costs for operators.

How competitive will the engine overhaul market be?
Customers have benefited from the competitive aspects of GE's MRO network, which delivers significant benefits including more choice of facilities, greater scheduling flexibility, lower costs via increased competition and higher engine residual value. As the installed base of GEnx engines continues to grow, GE is steadily expanding the GEnx MRO network, which currently consists of GE Aviation facilities in Caledonian, Scotland and Petropolis, Brazil; GE Evergreen Engines Services, a joint-venture facility in Taiwan; as well as facilities operated by Air France-KLM, Turbine Services & Solutions in Abu Dhabi, and Air India.

ENGINE DEAL OF THE YEAR 2014

THY picks up engine prize

The winner of the Engine Deal of the Year 2014 is an innovative $40 million spare engine financing on behalf of Turkish Airlines (THY).

This is the first time in Airbus's 43-year history that US Ex-Im Bank has financed any US-manufactured aftermarket component on a non-US aircraft.

The deal was structured for the financing of General Electric Model CF6-80E1A3 and General Electric Model GE90-115BL spare engines, to be fitted, respectively, to Airbus A330-300 and Boeing 777-300ER aircrafts.

The deal was initiated as Exim-guaranteed Japanese yen-denominated bank notes. At the first anniversary of the delivery date of the second engine, Turkish Airlines will have the option of flipping the bank notes to a single bond in an amount equal to 100% of the then outstanding aggregate principal amount of the bank notes.

"Using this structure we utilized a brand new source of funding for spare engines, a pioneering move in the industry," says Enis M Feyzioglu, general finance manager at Turkish Airlines.

The deal is also only the second US Ex-Im Bank-guaranteed Japanese yen-denominated financing with a capital markets take-out option. The first was arranged by Mizuho Securities and DBJ Securities and converted to an Ex-Im-guaranteed yen-denominated bond in June 2013 by Turkish Airlines.

The appeal of the deal for THY was that it helped mitigate its yen forex exposure. Turkish Airlines is long in Japanese yen. The cash flow structure being arranged in Japanese yen allows THY to hedge its currency risk by matching its excess yen revenues.

Turkish Airlines will have the option of converting bank notes into a bond if the capital markets offer better pricing at the take-out decision time. Crucially, the airline states there will not be a step-up margin for the bank notes if THY decides not to convert the bank notes into a bond, which removes any penalty if THY decides to forgo a take-out option.

The creation of security over a spare engine under Turkish law created some logistical challenges, notes Helfried J Schwarz, a Milbank partner who advised on the deal.

According to Schwarz, the spare engine could not be delivered at the manufacturing facility in the US but had to be shipped to Turkey where it was delivered to THY.

This transaction has expanded global access for the aviation community to ample Japanese capital and has aroused many Japanese investors' interest in the aviation sector. Furthermore, capital markets take-out could provide an even broader access for Turkish Airlines to new Japanese investors.

This transaction has broadened the choices of applicable currencies for export credit agency financing, which has been consecutively dominated by the US dollar.

Deal category: Engine Deal of the Year
Borrower/issuer: Turkish Airlines
Structure: US Ex-Im Bank-Guaranteed Spare Engine Financing
Amount: $40 million
Asset: 1 x General Electric Model CF6-80E1A3 and 1 x General Electric Model GE90-115BL
MSN: ESN 811-704 (CF6), ESN 907-610 (GE90)
Lawyers: Pillsbury Winthrop Shaw Pittman (THY), Milbank, Tweed, Hadley & McCloy (DBJ & Mizuho), Zuckert Scoutt & Rasenberger (US Exim)
Banks (and role): Development Bank of Japan and Mizuho Bank acted as lenders, and Development Bank of Japan and Mizuho Securities acted as arrangers
Export credit agency: Export-Import Bank of the United States
Date mandated: April 28 2014
Date closed: the first and the second engines' deliveries and financial closings were on June 17 2014 and August 7 2014 respectively.

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ENGINE SURVEY 2015

Investor poll rewards new engines

Investors have recognized engines powering in-production narrowbodies, as well as new engine types in this year's engine survey. Joe Kavanagh reports.

The 2015 *Airfinance Journal* engine poll is topped by the CFM56-7B, which exclusively powers the successful 737 next-generation family, and the CFM56-5B, which is one of the two powerplants available on the thriving A320 programme. The engines scored highly in the poll for investor confidence, as well as for remarketing potential and residual value.

IAE's V2500 engine, which is only available on A320 models, fared less well than in previous years, but remains a popular choice with investors. This year's poll also includes, for the first time, new engine models such as CFM's Leap-1A and Pratt & Whitney's PW1100G geared turbofan (GTF) that will power the fast-selling A320neo, which is due to enter service at the end of 2016. (The Leap-1B, which will be the sole powerplant on the 737 Max, is not included in this year's poll because the aircraft's entry into service is significantly later than the Neo).

Although the market for engines is smaller than the aircraft market, the assets hold their value better. Joe O'Brien of Engine Lease Finance Corporation (ELFC) stresses that an engine's investment appeal is crucially related to its residual value. He adds: "Anyone in our business that doesn't understand that is in trouble."

The stronger the investment appeal is for an aircraft, the stronger the market will be for the engines that power it. The factors that govern the two markets are very similar: the values for both are affected by whether the asset is in or out of production, the spread of its operator base and liquidity.

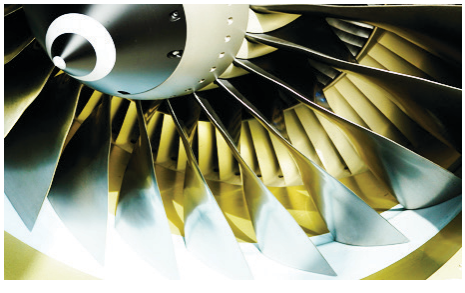
Best-performing engines

As in previous years, in-production engines have performed highly compared to their out-of-production counterparts. Robert Korn, president of Apollo Aviation, explains that he prefers to invest in current assets.

"We're very focused on in-production aircraft. The out-of-production market is not as stable an investing environment," he says.

The CFM56-7B once again came in at number one in this year's poll across all three categories (investor appeal, remarketing potential and residual value). This is unsurprising given the engine's exclusive status on the Boeing 737NG family.

With a large operator base and a liquid market for the aircraft, the engines are highly desirable assets. Korn adds: "The -5Bs and -7Bs are absolutely killing it. That's where everyone is putting their money right now."



He adds: "[CFM] has created a liquid market. It has gone out of its way to make sure that its residual equipment maintains its value."

This 2015 poll includes a number of engine models that are yet to enter service. The Leap-1A and PW110G, and the powerplants for Airbus's incoming A320neo family of new-engine narrowbodies have performed strongly in this year's ratings.

It appears that investors believe there will be strong demand and a liquid market for these engine models. There was similar optimism for the aircraft in this year's *Airfinance Journal* Operators' and Investors' poll, where the A320neo and A321neo topped the charts with scores of 4.51 and 4.47 out of five respectively.

Another new entrant in the engine poll is the Trent XWB, which entered into service at the end of last year on the A350 XWB with launch customer Qatar Airways. Investors believe this engine represents a good investment, and have awarded strong scores to the asset.

Oversupply driving down lease rates

It is difficult to identify general trends of lease rates, because different variables affect specific engine models and variants. However, a number of new leasing players have sprung up in recent years, particularly in the mid- to end-of-life markets, and some investors say that they are putting pressure on lease rates in general.

Asked about lease rates, ELFC's O'Brien says the leasing market is suffering in some spaces from oversupply.

He adds: "It's impossible to put a general comment on lease rates, because all the assets are different, but generally speaking there is oversupply in the market for spare engines right now because of all the green time [remaining engine life]. That is pushing short-term leasing rates down. Some markets are recovering, but not quickly enough."

Dan Coulcher, senior vice-president and chief

"The majority of new entrants are part-out companies, so there's much more pressure at the older end of the market."

Dan Coulcher, SVP and chief commercial officer, Willis Lease Finance Corporation

commercial officer, Willis Lease Finance Corporation, says: "The majority of the new entrants are part-out companies, so there's much more pressure at the older end of the market. That means, on the older programmes, you're suddenly seeing a whole bunch of engines that are being offered for green time leasing, at below market rate."

Although the pressure at the moment is more obvious at the older end of the market, if this year's poll is borne out, investors will be chasing the new engines entering service next year. In particular, if investor action reflects the survey, there should be considerable appetite for Leap-1As and PW1100Gs.

From this latest *Airfinance Journal* survey, it seems likely that the engines powering current A320s, 737s and popular widebodies will maintain their appeal as investments alongside the newer engine models as they enter service. But that is a question for next year's poll.

MANUFACTURER RATINGS	
EASE IN FINANCING PRODUCTS (OUT OF 7)	
CFM	6.43
GE	5.88
IAE	5.50
Pratt & Whitney	4.75
Rolls-Royce	3.88
FINANCIAL SUPPORT OFFERED (OUT OF 7)	
GE	5.80
CFM	4.80
Pratt & Whitney	4.38
IAE	4.00
Rolls-Royce	3.75
PRODUCT SUPPORT (OUT OF 7)	
GE	6.13
CFM	5.86
IAE	4.88
Pratt & Whitney	4.38
Rolls-Royce	3.75

RESIDUAL VALUES IMPACTED BY MANUFACTURERS

The main concern of investors in this year's *Airfinance Journal* engine survey is residual values. Respondents to the poll indicated that increasing control of the market by engine manufacturers may be threatening engine values at the end of their economic life.

At issue is whether residual values are under threat because of increasing dominance of the maintenance, repair and overhaul (MRO) market by the engine manufacturers and other original equipment manufacturers (OEMs). Investors are also noting that lease rates for certain assets are being squeezed by oversupply in the leasing market. The results of this year's poll reflect the concern. For all but three engine types, the scores for residual values are lower than those of 2014.

Investors and industry analysts have for some time expressed concern about the increasing dominance of the MRO market by OEMs and, in particular, there is increasing concern about what happens to the residual values of engines that are covered by OEM support packages.

Manufacturers are able to recoup extensive development costs by offering comprehensive support packages for their engines. Under these deals, often termed "power-by-the-hour" arrangements, the operator pays a fixed rate for maintenance and the OEM undertakes to cover the cost of engine overhauls as they are required. Airlines benefit from these arrangements because they offer predictable maintenance costs for their engines, but it is difficult for third-party maintenance providers to compete with these OEM schemes. This is leading to a reduced number of engine MRO providers. Since the MRO market accounts for a large part of the demand for spare engines this trend leads to a decrease in the number of potential buyers of spare engines, with an inevitable impact on residual values.

Paolo Lironi, chief executive officer, SGI Aviation, says aftermarket dominance by OEMs raises a question mark over the residual values of certain engine types. Rolls-Royce's Trent 700, he says, is an example of such an engine. "The value of a Trent 700 is how much Rolls-Royce is willing to pay. There is only one buyer, which is Rolls-Royce," he says.

Lironi adds: "The problem that lessors are having is the residual value for their aircraft with

those two engines installed, and that is hurting Rolls, since it's normally easier to place an aircraft without Rolls engines than with a Trent engine."

Lironi also predicts that new engine types will be increasingly sold under comprehensive service agreements.

"For the new engine models, GEnx, Leap-X and the PW GTF, I think the OEMs are putting things in place to gain 100% of the aftermarket. They are doing everything they can to close the market, not to open it up," he adds.

However, speaking to delegates at Istat's Americas conference in March, OEM executives defended themselves against the charge that they were closing up the MRO market by offering comprehensive support packages.

Jean-Paul Ebanga, president and chief executive officer, CFM International, says CFM was committed to maintaining an open MRO market. However, he adds: "As our new generation of engines become more and more complex, customers are looking for some kind of insurance in terms of maintenance cost and so on. This is the reason why we offer them this long-term comfort. So we are going to continue to manage this mix."

Meanwhile, James Barry, senior vice-president of marketing, Rolls-Royce, says the company's engine support offered value to its airline customers.

"Total Care is the world's premier service for aftermarket services. Our customers tell us they're delighted with it, that it's improved their business," says Barry.

He adds: "It's less about open or closed and more about giving customers choice of service."

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Investors pick their favourites

Investor appeal	(out of 7)
CFM56-7B (737NG)	6.38
CFM56-5B (A320)	6.00
CFM Leap-1A	5.71
GEnX (787)	5.14
PW1100G (A320neo)	5.14
GE90 (777)	5.13
Trent 700 (A330)	4.57
Trent1000 (787)	4.43
V2500-A5 (A320)	4.38
CF34-10 (E-Jets)	4.29
Trent XWB	4.17
CF34-8E (E-Jets)	3.57
PW127 (ATR)	3.50
CF34-8C (CRJ)	3.43
CF6-80 (747-400s, 767s)	3.00
PW150A (Q400)	2.83
Trent 800 (777)	2.75
PW4000 (747-400s, 767s, 777s)	2.63
GP7200 (A380)	2.57
Trent 900 (A380)	2.14
PW2000 (757)	2.13
RB211-535 (757)	2.00
CFM56-3C (737Classic)	1.63
CFM56-5A (A320)	1.50
CFM56-5C (A340)	1.38
PW6000 (A318)	1.25
V2500-A1 (A320)	1.14
Trent 553 (A340-500)	0.86
Trent 556 (A340-600)	0.86
RB211-524 (767, 747-300, -400)	0.83
JT9D (747s, 767-200)	0.57

Remarketing potential	(out of 7)
CFM56-7B (737NG)	6.50
CFM56-5B (A320)	6.00
CFM Leap-1A	5.67
PW1100G (A320neo)	5.50
GEnX (787)	5.29
GE90 (777)	5.13
Trent XWB	4.60
V2500-A5 (A320)	4.50
Trent 700 (A330)	4.29
Trent1000 (787)	4.29
CF34-10 (E-Jets)	4.00
PW127 (ATR)	3.83
CF34-8C (CRJ)	3.43
CF34-8E (E-Jets)	3.43
CF6-80 (747-400s, 767s)	3.13
PW150A (Q400)	3.00
PW4000 (747-400s, 767s, 777s)	2.88
PW2000 (757)	2.25
Trent 800 (777)	2.25
RB211-535 (757)	2.14
CFM56-3C (737Classic)	2.00
CFM56-5A (A320)	2.00
GP7200 (A380)	1.86
Trent 900 (A380)	1.86
CFM56-5C (A340)	1.63
PW6000 (A318)	1.25
V2500-A1 (A320)	1.14
JT9D (747s, 767-200)	1.00
RB211-524 (767, 747-300, -400)	0.83
Trent 553 (A340-500)	0.71
Trent 556 (A340-600)	0.71

Residual value	(out of 7)
CFM56-7B (737NG)	6.13
CFM Leap-1A	5.67
CFM56-5B (A320)	5.63
PW1100G (A320neo)	5.17
GEnX (787)	4.86
GE90 (777)	4.75
Trent XWB	4.60
V2500-A5 (A320)	4.25
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SPONSORED EDITORIAL

MTU expands engine leasing service

MRO provider MTU Maintenance is offering new integrated engine leasing solutions to help maximize engine value for its customers.

MTU Maintenance has been in the maintenance, repair and overhaul (MRO) business for more than 35 years. Beginning life as a small repair shop in Hannover, Germany, the company has gone from strength to strength and become one of the world's leading MRO service providers for commercial aero engines.

After its foundation in 1979, the company commenced the repair of the CF6-50 engine, with the CF6-80 and V2500 models being added about a decade later. MTU was the first maintenance provider to start with the repair of the V2500 and, with more than 3,700 shop visits, the company is number one worldwide for MRO work on this engine type.

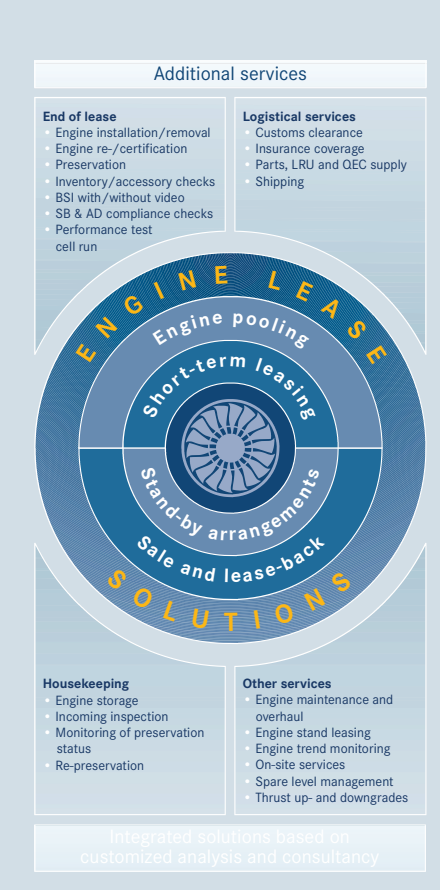
MTU has grown to become a global provider with a worldwide network of facilities in Asia, Europe and North America and an impressive portfolio that serves more than 25 different engine types – among these the CFM56, the CF34 and the world's largest engine, the GE90.

Leo Koppers, the company's senior vice-president of sales and marketing, says MTU Maintenance holds a "special position" in the MRO market.

"Our success is based on a hybrid business model as we benefit both from our independent approach and our close alliance to the OEMs [original equipment manufacturers] in engine programmes where our parent company MTU Aero Engines is a risk and revenue share partner," he said in a statement last year.

MTU Aero Engines is Germany's largest engine manufacturer and has specialized in designing and manufacturing the low-pressure turbine, high-pressure compressor or turbine centre frame of many popular engine types – for example, the V2500, as well as future engines such as the PW1000G and the GEnx.

"MTU has completed over 15,000 shop visits, and we have gained quite a strong reputation as an alternative engine MRO service provider," adds Koppers. The company not only focuses on traditional engine overhauls, but also offers customers additional services to help them save MRO costs. Among these are engine lease or exchange solutions, on-wing services, engine trend monitoring, LRU management and accessory repair. All services are individually adapted to a customer's needs and can be combined with each other as part of MTU's Total Engine Care package.



Expansion of leasing business

As part of offering spare engine support to its MRO customers, MTU has been building up an engine lease pool since the late 1990s. The company's most recent plans are to expand the scope of its leasing services to include non-MRO clients as well.

One reason for expanding its lease business is so that MTU can respond even better to the spare engine needs of its customers, because the current trend is for airlines to free themselves from costly spare engine ownership and to enter into more flexible and cost-efficient lease solutions instead. MTU's portfolio comprises about 30 to 35 engines. Engines in high demand, such as the GE90, have been added and the mid- to long-term revenue target is expected to amount to about $100 million.

>>>

MTU combines the strengths of being both a lessor and an engine MRO provider.

In September 2013 MTU announced the formation of two joint ventures with leading Japanese trading house Sumitomo Corporation and opened offices in Amsterdam dedicated to this partnership in April last year.

MTU holds an 80% stake in MTU Maintenance Lease Services BV and also took a 10% participation in Sumisho Aero Engine Lease, which concentrates on long-term leasing activities. MTU's former engine lease activities, which focused on spare engine support during shop visits mostly for MTU's engine MRO customers, have been transferred into the new joint venture.

MTU's relationship with Sumitomo has many advantages, from risk sharing and new financing possibilities to additional customer and market access, to name just a few.

The relationship dates back nine years, MTU Maintenance Lease Service's managing director Martin Friis-Petersen tells *Airfinance Journal*.

"Sumitomo has successfully been supporting MTU Maintenance to enter into the Japanese market as an engine MRO provider," he says, speaking from the office in Amsterdam.

"We are not completely unknown to each other and gained a lot of past experience and past comfort working with each other, so it was a natural step partnering up with them," he adds.

"Sumitomo gives us additional market access via SMBC, the world's third-largest aircraft lessor and its aviation activities in Tokyo, so it's a perfect fit. Additionally, we saw an opportunity to provide our customer base with access to attractive and competitive financial solutions like engine sale and leaseback arrangements via our partner as well."

The new joint ventures offer an innovative range of integrated spare engine support solutions – from ad-hoc short-term leasing and standby arrangements to cover a shop visit to engine pooling and dedicated long-term engine leases. With MTU's background as an engine MRO provider, the company can also offer additional services to its lease customers such as end-of-lease inspections, line-replaceable unit and quick engine change supply, housekeeping and engine MRO services.

Optimizing asset usage and value

Friis-Petersen explains that MTU Maintenance and its lease service's activities go beyond the realm of a traditional engine lessor.

MTU Maintenance Lease Services BV allows MTU to offer comprehensive solutions over the entire engine life cycle, from financing through trusted partners to ensuring optimum asset management and cost-efficient support from the delivery of the engine to the recovery of serviceable components at the end of the engine service life.

"We are not only a leasing company," he says. "We also provide asset and material management solutions; for us this is an interesting business opportunity looking at the increasing amount of aircraft and engine retirements."

He estimates that more than 700 commercial jets will be retired globally this year, growing to above 800 a year within the next two years. This presents a great opportunity for MTU's business because the additional surplus material available can be used to reduce engine MRO cost.

"On the one hand, with intelligent material solutions we want to provide our customer base with even more optimized MRO solutions," he says. "On the other, we are broadening our activities and are now also trading engines and selling used serviceable engine parts to third-party customers."

Best of both worlds

Customers clearly benefit from the fact that MTU combines the strengths of being both a lessor and an engine MRO provider.

"As opposed to traditional lessors, we have in-depth engine knowledge and can easily assess the value of the asset – either as a whole or as the sum of its parts," says Friis-Petersen. "One way for operators to generate additional value is for us take their engines into our lease pool and remarket them to others."

MTU also can determine the perfect timing for an engine teardown – ie, when the teardown value exceeds potential revenues from leasing. All teardown services can be performed in-house, and parts used for its consumption as an MRO or sold outside its MRO network. This is a procedure MTU now realizes for engines in its own pool, but it can easily be adapted for third-party engines as well.

"We are one of the very few companies that is able to provide so-called one-stop engine life-cycle solutions," he says. "MTU can add value throughout the entire cycle – from the acquisition of the asset, its operations to the final phase out. That is actually a real alternative to what the market has to offer otherwise."

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SPONSORED EDITORIAL

Engine specialists – do I need one?

Alan Fournier, business development manager at TES, explains how getting the right engine advice is always a good investment.

Independent engine specialists can occasionally be perceived as an unnecessary service from in-house airline or lessor engineering departments. I would like to try to expel this portrayal – their main aims are far from taking over their roles and responsibilities; they are to build relationships while enhancing operational efficiencies.

Over the life of an aircraft the engines are the most important asset in terms of retained value – provided they have been properly maintained both technically and regarding engine records. Some level of technical expertise is of course essential to maintain operations and, although, there is considerable focus on cost exposure, in-house engineering departments do not always have the necessary knowledge or, more importantly, the time to carry out cost-reduction initiatives. This is just one example of where outside expertise can be sought in the form of specialist engine advisers such as TES.

In order to understand how to get the best from engine specialists we first need to understand where they can be utilized. Tasks such as fleet tracking through to more complex projects such as those of market dynamics and future technical and financial planning can all be accomplished.

Take, for example, the concept that an aircraft and its engines have a life cycle starting at the selection process, then moving to in-service operation, sometimes with several operators, and finally the end-of-life solution, all of which can take place over 25 years or more.

Let us now explore some of the main touch points that independent specialists can have within the engine life cycle, and how to achieve excellence in these areas while maintaining budgets and quality of service.

Fleet introduction

When an airline adds an aircraft to its fleet (owned or leased) there are a number of critical aspects that need to be considered.

For potential owned assets, the engine selection process is critical when looking at acquiring a new aircraft. Influences such as engine purchase price, residual value, warranties, fuel burn, time on-wing, maintenance costs and life limited parts (LLP) lives are some of the most critical points to consider.

Using actual data gathered from operation to determine accurately future maintenance and operational budgets, including analysis of detailed information on reliability, maintenance, repair and overhaul (MRO) networks and used material availability, can have a huge effect. Benefits of using independent specialists to perform this analysis range from utilizing the extensive industry knowledge based on data collected from years of managed engine experience, to the detailed technical knowledge of specific engine hardware used when building in-depth financial models.

For example, an analysis of a maintenance cost per hour contract offered by one of the main engine manufacturers was reviewed by TES on behalf of an airline. During such review it was noted that financial structure was considered to be well above acceptable levels used throughout the industry, potentially resulting in the financials over the term becoming unviable while exposing the airline to numerous unacceptable risks. Without the intervention of an independent expert, millions of US dollars would have needlessly been consumed.

If leasing is the preferred method of introduction, then the lease contract negotiation is a highly important area because specific terms within the lease can make or break a lease for either lessee or lessor.

From a lessee standpoint, paying the right amount of maintenance and LLP reserves is a delicate balance: pay too much and you cannot claim it back; pay too little and you expose yourself to significant shortfalls when engines undergo maintenance.

For smaller airlines this type of unexpected cost outlay can sometimes make or break the airline. On the other hand, from the lessor point of view, the risk of putting their high value asset in the hands of someone else poses a risk, and this risk must be mitigated. In an unfortunate event that a lessor is required to repossess an asset, the maintenance reserves (MR) will ensure the assets value can be maintained, therefore the MR must be sufficient to do so in the first place. Independent engine consultants can provide detailed analysis for the lessees and lessors, ensuring the MR rates are sufficient to cover risk for the lessor while being attractive to lessees.

One contractual ambiguity seen time and time again is the definition of a "qualifying" maintenance event at which maintenance reserves can be claimed. Wording is often too vague and many lessees do not always have a full understanding of the potential implications. Recently a lessee sent an engine in shop only to find that the workscope did not meet the minimum requirement to claim maintenance reserves. This could have been avoided by using, before the shop visit, an experienced engine specialist fully conversant with lease contract requirements and engine workscopes. This is also valid for lessors, because sometimes lessors end up releasing maintenance reserves despite the fact the shop visit workscope was not a true qualifying event.

Another item often overlooked is to do with delivery/return conditions. It is surprising how little importance some lessees place on the delivery/return conditions. It is usually at the end of the lease, when they are trying to return the aircraft to the lessor, that they fully realize the financial implications of certain contractual clauses.

An aircraft being transitioned from one operator to another is a lengthy and sometimes challenging process. Ensuring this process is smooth and that all contractual obligations have been adhered to can be time and resource intensive. When using engine specialists for this task there are key areas that are focused on to ensure a risk-free transition. Engine records are of paramount importance in this process and, without specific documents, such as back-to-birth trace reports for the LLPs, the engine can

"Throughout the process of the shop visit engine specialists such as TES can provide insights and advantages of potential cost savings and where parts could be recovered or replaced with used serviceable material to further reduce costs while maintaining quality and reliability."

be essentially worthless.

Physical inspections are also an important process in the management of engine transitions, coming in the form of external inspections to ensure the correct engine and associated powerplant hardware is present. One of the final tasks before the delivery is the BSI inspection of the engines. These are of vital importance and ensuring the expertise to analyze the exact condition and findings is essential. Declaring an engine serviceable based on AMM limits is one thing, ensuring an engine meets redelivery conditions is another.

Previous experience has shown how whole aircraft deals have hinged on the BSI of engines; knowing the specific problematic areas of each engine can save millions of dollars in the long term – engine specialists on the whole have this knowledge and with an appropriate team behind them can predict, for example, the time on wing remaining, enabling maintenance and ultimately financial planning.

MRO selection/fleet planning and management

On average about 42% of the total direct maintenance costs of an aircraft are affiliated to the engines. Data presented to International Air Transport Association also states that 79% of the MR paid to lessors are allocated to the engines. These are huge portions of the operating budgets that must be carefully controlled.

The main expense on engine maintenance are the shop visits, therefore experience of the MRO network is needed, as well as the scrap rates at typical maintenance events. TES, for example, has access to more than 20 years' shop visit data with huge numbers of shop visits managed over the past three years alone combining current and historic data, covering a full range of engine operating conditions and parameters, thus providing accurate forecasting comparable to that of an experienced operator with a large and varied fleet.

Before the scheduling of engine maintenance events, actual maintenance planning and fleet management is required to enable these predictions to take place. During a recent review of an engine maintenance contract proposal the engine specialist was able to provide a maintenance event plan for the whole term and beyond, highlighting to the airline that many maintenance events would fall outside of the initial term, and therefore would have a significant impact on the overall maintenance costs. It is worth noting at this point that the influences on the fleet planning need to be clearly understood to be able to do this accurately, which is where independent specialists such as TES come into their own.

With average restoration shop visits costing in the region of $2 million to $4 million for narrow-body aircraft engines, the importance of selecting the right MRO is essential. For example, engine specialists are able to normalize the offerings of various MROs to compare apples with apples. There is no benefit in comparing an NTE from one shop with another, when the inclusions and exclusions are completely different.

Another important phase in maintenance cost control is the development of the engine workscope; large cost reductions can be achieved through appropriately workscoping the engines. For example, overhauling the low-pressure modules when the LLPs meet the build goal and the condition does not drive you to do so is not cost effective, although sometimes this is required so that the engine workscope meets the definition of a qualifying shop visit as commonly defined in lease contracts.

Throughout the process of the shop visit engine specialists such as TES can provide insights and advantages of potential cost savings and where parts could be recovered or replaced with used serviceable material to further reduce costs while maintaining quality and reliability.

To preserve turnaround time some MROs routinely utilize standard exchange; however, this can have an impact on engine hardware standards, specifically regarding HPT hardware, where high value components are situated.

The overall value of the asset can be heavily affected should a change in standard occur in shop. An additional sting in the tail can occur in the final shop visit costs when taking into account handling fees for the exchanged hardware. Post-shop visit conducting a detailed invoice review is another important aspect to consider and often neglected. Regularly tens of thousands and often hundreds of thousands of dollars can be saved at each shop visit just through a comprehensive invoice review. At this point it is important to note that an experienced engine specialist can manage the shop visit to mitigate these risks while allowing in-house engineering functions to remain focused on daily operations that keep the airline running.

End of life

With engines lasting way beyond their airframe counterparts, exit strategies are becoming more and more important to airlines and lessors. There are several options available, all with their own unique merits. These range from engine teardown, consignment programmes to engine sale/leaseback to burn green time. Phase-out programme modelling requires in-depth industry knowledge and strategic planning because many organizations are already professing to extract value from end-of-life assets.

When utilizing engine specialists, such as TES, you benefit not only from tapping into a single person's knowledge, but the wealth of knowledge of an established company which can offer not just technical expertise in the form of powerplant specialists but also legal, materials, warehousing, logistical and asset management specialists: a team of industry experts that can find solutions to the most complex problems.

Engine specialist organizations such as TES pride themselves on their up-to-date technical and commercial industry knowledge. Airlines and lessors may not have the technical capacity and time to keep constantly abreast of the continual improvements across all products, whereas engine specialists rely on this adept understanding to bring value to their customers.

The aviation industry is a small community and reputation counts, therefore long-term partnerships are a pathway to success.

SPONSORED EDITORIAL

SES customises spare engine leases

Shannon Engine Support reacts to a changing spare engine market as it prepares for the LEAP engine.

Julie Dickerson
Managing Director
Shannon Engine Support (SES)

Established in 1988 to support the service entry of the CFM56, Shannon Engine Support (SES) has grown to become the largest lessor of the world's most popular commercial jet engine. The CFM International subsidiary currently owns or manages close to 200 CFM56 engines, has 10 established engine pool locations in seven countries allowing for 24/7 access to its engines, and counts more than 150 CFM operators, MRO's and Aircraft Lessors in its active customer base.

The SES portfolio largely comprises the CFM56-5B and CFM56-7B models, including the newest CFM56-5B PIP and CFM56-7BE configurations, as well as some of the older non-TI technology, and also includes a smaller number of CFM56-3, -5A and -5C engine types. In 2012 the company placed its first order for LEAP-1A/1B engines with first deliveries scheduled for 2016.

Julie Dickerson, SES's Managing Director, explains that "while there is still a market for the older technology such as the CFM56-3, our main focus is on supporting the CFM56-5B and CFM56-7B markets, and on LEAP as it enters service in 2016".

In addition to its commercial leasing business which includes management of a number of CFM56 portfolios on behalf of third-party investors, SES also provides support to CFM International for product support related issues and will continue to provide the same support for the LEAP engine family as it enters into service.[1]

Technical support, logistics, storage and maintenance of the SES CFM56 engine portfolio are provided through a series of strategic alliances with a number of airlines and MRO shops worldwide. SES Engine pool locations are chosen based on operator/

fleet concentration to ensure CFM56 engines are available from locations that are accessible to customers around the clock and are in close proximity to expected demand. Naturally, all SES engines are maintained to the original equipment manufacturer's (OEM) TRUEngine standard, and all overhauls are handled in CFM56-licensed maintenance facilities.

In addition to the more conventional offerings such as ad-hoc leases, operating leases and engine sale and exchange programmes, SES has developed a range of customised lease programmes for a number of CFM operators as an alternative to traditional spare engine ownership models. Susan Keating, senior vice president sales & marketing, explains that such programmes have been developed in response to demand from operators for increased efficiency across all aspects of their operation. "Efficient deployment of capital continues to be a critical factor for operators. Where asset usage is low, airlines are looking for alternatives to the more traditional ownership models which leave asset downtime and the associated cost with the operator" says Keating. As airlines continue to expand and develop, this need to preserve capital and liquidity will continue to support the growing demand for dynamic spare engine solutions.

Working closely with its customers, SES evaluates the operator's spare engine needs

[1] *Both CFM56 and LEAP engines are products of CFM International, a 50/50 joint company between Snecma (Safran) and GE.*

"Our experience in CFM56 and established track record in delivering on commitments to our customers adds real value in an environment increasingly driven by financial vehicles which can lack a longer-term customer focus and commitment."

over a given period and builds a programme to deliver the most appropriate level of spare engine coverage required to meet both scheduled and unscheduled demand, month by month. Through these programmes, the company effectively removes the carrying cost of excess spare engine capacity from the airline and redeploys it elsewhere across the CFM operator base under similar programmes. Customised programmes are fully scalable and can be tailored to any fleet size and to take into account varying levels of spare engine cover required by the airline. Today the company provides such programmes for operators with fleet sizes ranging from fewer than 10 aircraft to more than 200, each of which has varying levels of spare engines available within fleet, so the range of support delivered is extensive. Importantly, it also allows an airline to adjust its fleet capacity without the added challenge of matching spare engine capacity to meet a changing fleet profile.

The industry-leading reliability of the CFM56 engine also has been a factor in the evolution of SES's business model in which the lessor has experienced an increasing reluctance on the part of airlines to carry excess spare engine capacity on the newer technology relative to earlier engine models. "This is due in no small part to the reliability of the CFM56 product line" notes Dickerson. "The CFM56 product has proven so reliable that engines have been staying on wing a lot longer than originally anticipated so the lease market remains a little soft in that regard. However, the demand situation is likely to change with shop visits projected to increase by close to 10% year on year, so we expect to see corresponding increase in lease rates as supply becomes a little tighter over time."

With nearly 28,000 CFM56 engines delivered so far, the popularity of this asset makes it a favourite for investors, so there is plenty of competition in the leasing space.

Dickerson explains "there are no other Lessors that are entirely dedicated to CFM but we are starting to see a lot of additional competition in the market as the asset reaches a mature phase." Another factor fostering competition is the openness of the

CFM market. "The OEM approach has been open", explains Dickerson. "For example, we have speculative orders for new engines, as have some of our competitors. I think if you look at some of the other OEM's their approach to market is to limit access to it. Whereas with CFM, because it is a very successful engine and such a large and open market, there has been a lot of financing required for spare engines which in turn has been very appealing for investors."

SES believes that a strong customer focus and understanding are the most significant drivers of any service organization. For 26 years, the company has placed the customer at the centre of its organisation and nurtured customer loyalty by delivering CFM engines, in the required configuration, at the right time. "Our experience in CFM56 and established track record in delivering on commitments to our customers adds real value in an environment increasingly driven by financial vehicles which can lack a longer-term customer focus and commitment," notes Keating. "SES is a CFM-owned company so we're in this for the long-haul and to support the CFM operator base throughout the entire product life-cycle."

As the industry continues is ascent out of the recent economic downturn, the expectation is that airlines will continue to view engine leasing favourably, turning to SES and others in the market to gain financial flexibility and operating advantages. "SES is well positioned to meet the demands of a maturing market" says Dickerson. "We have the advantage of a highly experienced team coupled with a well-established global presence and a reputation for quality. As a result we can act very quickly to give operators and MROs flexible solutions designed for their unique requirements. We continually evaluate and expand the scale of our offerings to enable us to provide our customers with value-add turnkey solutions for their spare engine planning."

Next year SES will start taking delivery of its first LEAP engines, supporting entry into service as it has done on the CFM56-5B and CFM56-7B. Dickerson is looking forward to continuing to grow the business to deliver optimum lease solutions, both with current technology and next generation technology, as customers continue to see the operational and financial benefits of leasing spare engines. "Over our 26 year history, we have become the CFM56 spare engine lessor of choice for airlines and MRO providers alike. Adding the LEAP engine to our portfolio is a big step in implementing our long-term strategy to offer a comprehensive spare engine offering across the entire CFM56 and LEAP engine operator base. We have made some major investments in the past 24 months and look forward to our customers seeing the benefit of that going forward".

SPONSORED EDITORIAL

Mature engines should excite investors

IBA analyst David Archer reviews the enduring appeal of the older engine market.

The prevalent talking point in our industry is often the acquisition and application of next-generation aircraft to the growing fleets of the most thriving airlines. Likewise in the engine market the focus is on the new engine options coming to market, performance improvement packages to existing engines, the large order books and what benefits they bring.

Often put to one side are the mature aircraft and engines that are still needed to support on-going operations. In these established aircraft markets anywhere from 80% to 100% of a mature aircraft residual value can be found in the engines alone, and the engine value requires careful assessment as the largest determinant of overall aircraft value.

At this point in maturity there are two factors any operator will assess when reviewing options for older engines: first, is there an unnecessarily high cost to keep it in service, and second, is there an alternative that balances outlay and operational requirements? Over time, as manufacturers no longer support the older equipment, third-party maintenance, repair and overhaul (MRO) companies and independent specialists step in to ensure the stable and cost effective use of the older engines through whatever means are feasible.

Eventually the value of fully maintaining the engine will be outweighed by what could be achieved in the secondary market through either direct sale of the engine or breaking the engine down for valuable components and selling them individually to end users. Common practices include the use and acquisition of a stub-life/green-time engine or engine module building.

Mature engine examples

The CF6-80C2 and the PW4000-94 are two directly competing engines at a mature point in their respective life; both were offered to the same aircraft and both produced very similar levels of thrust. However, the CF6-80C2 achieved a greater population and was largely preferred as the freighter operators' choice of engine for P2F (passenger to freighter) programmes.

The following tables compare the PW4056 against the CF6-80CB1F due to their similarities in application and age. Figure 1 shows how the market has become saturated with both of these engines in the last year especially, as operators seek to upgrade their current fleet with the latest next-generation aircraft. Figure 2 shows the effect this has had on the engine's market values both now and historically, although this is also in part because of the diminishing demand for both.

The CF6-80C2 is well supported by the freighter industry with the two top operators, Federal Express and UPS, operating more than 450 engines between them on various aircraft models. The PW4000-94 also has significant freighter operators; however, it has a smaller presence in the largest operators' fleets.

So what has driven the values to be closer in this example? With the on-going modification to the Ring Case Combustor, Pratt & Whitney purchased PW4000-94 engine variants removing them from the market, reducing the supply. This ensured what remained was of a quality standard and any surplus would again be part of their aftermarket stream for maintenance and component supply.

With the removal of material and shift back to original equipment manufacturer (OEM) reliance, to a certain extent, the demand was met with a more controlled supply and values have been maintained to a level closer to the CF6-80C2.

Observing trends from another mature engine, the JT8D-200 is one of the oldest still in commercial operation. With development dating back to 1959, it was the sole engine choice on the MD-80 family of aircraft. The series is entering the final stages of its life over the coming decade as its largest operator, American Airlines, begins to phase them out of operation but values have been maintained at a constant low level for the past few years.

You can see the change in the user base once the engine began to mature, as smaller and more diverse operators would take on the retired aircraft from primary operators seeking to update their aircraft

Figure 1 - **PW4056 vs. CF6-80CB1F Engine Values (US$M)**

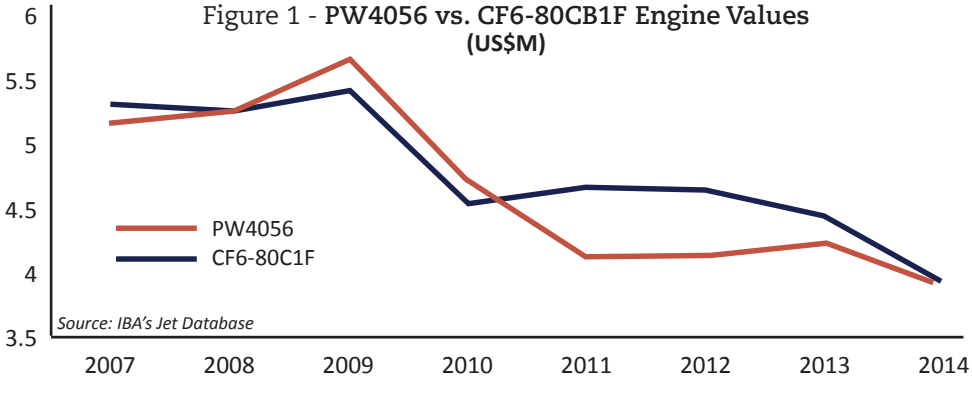
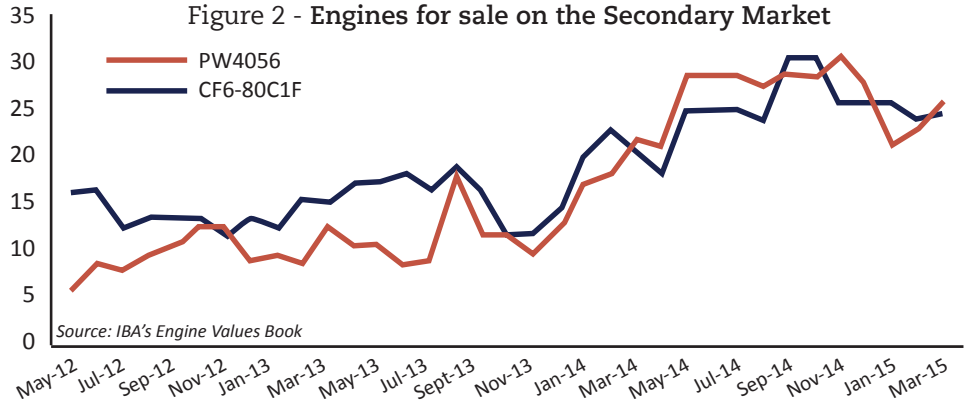


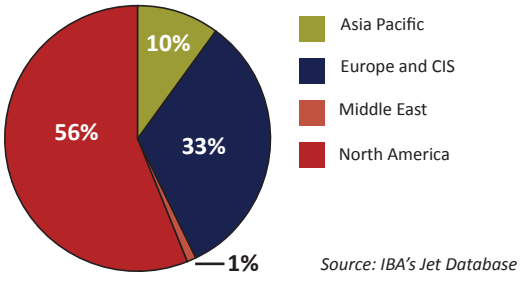
Figure 2 - **Engines for sale on the Secondary Market**



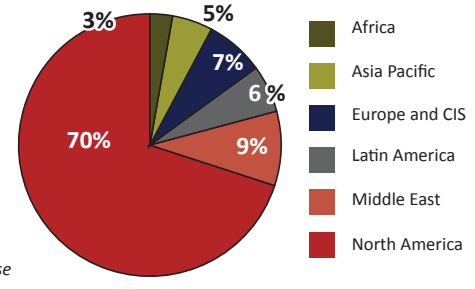
"Mature engine values must be analyzed differently to younger engines as there is no OEM list price, the engines are simply worth what the market is willing to pay."

Figure 3

Initial MD-80 Regional Split



Active MD-80 Regional Split



Source: IBA's Jet Database

portfolio. This can be clearly seen in Figure 3, with Europe's share shrinking significantly while secondary operators in other regions acquired what was to them a superior option to their existing aircraft, with some of them choosing the MD-80 over the even older DC-9 aircraft, which some operated until recently.

What can also be clearly seen is the considerable size of the North American fleet. This is made up of two key players: American Airlines and Delta Airlines. As American Airlines phases out its fleet, something Delta is also expected to carry out during the next decade, the secondary market will be awash with material, and the market value of spare parts and engines will be nullified. Like now, it is likely that such aircraft will garner little interest and the majority will become just another parked aircraft.

Why do we have to scrutinize the value more closely?

Mature engine values must be analyzed differently to younger engines, because rather than the OEM setting the list price as a point of reference, the engines are simply worth what the market is willing to pay. For the appraiser this entails regular interaction with parties which have a vested interest in those particular engine markets.

Maturing engines tend to be more readily available within the market, because production has significantly tapered off and operators are retiring the host aircraft.

Further, because of the volatility of the market and the effect so many variables can have on the potential value, special attention must be paid to mature engines to ensure an accurate assessment. It is for this reason appraisers often start the valuation from the core value, adding in value from the remaining green-time and engine life limited parts (LLP) life – this methodological approach is seen as more representative of the market at this point in the engine's life.

As an example, the JT8D's value has fluctuated significantly over the past decade, as is shown in figure 4. While in 2000 the JT8D was still a mature engine, the effect of the 9/11 attacks in 2001 and the recession in 2008 are very pronounced, as the least valuable assets become the least desirable assets. While the values have been stable for the past few years, this is mainly because of the market bottoming out with fairly constant levels of supply and demand.

How the engine value can be impacted

A key variable in the value of these mature engines is the rate at which aircraft are being parted out and the engine configuration. In the case of the CF6-80C2 or PW4000-94, a single 747-400 being retired provides four additional engines to the market, whether directly or indirectly. This has been an occurrence over the past few years for these two engine series and a 10% to 15% drop in their value because of increased storage and aircraft part outs has been exhibited.

These value changes are important to operators' decisions; with an ageing engine, a performance restoration could easily cost above $4 million, whereas replacing the engine or key LLPs could significantly reduce these costs and provide enough time on-wing easily to recoup the costs involved. On the other hand, operators willing to run out the engine can use the parts coming back into the market to add valuable time on-wing for the engine at a significantly lower cost.

Where is the market for mature engines?

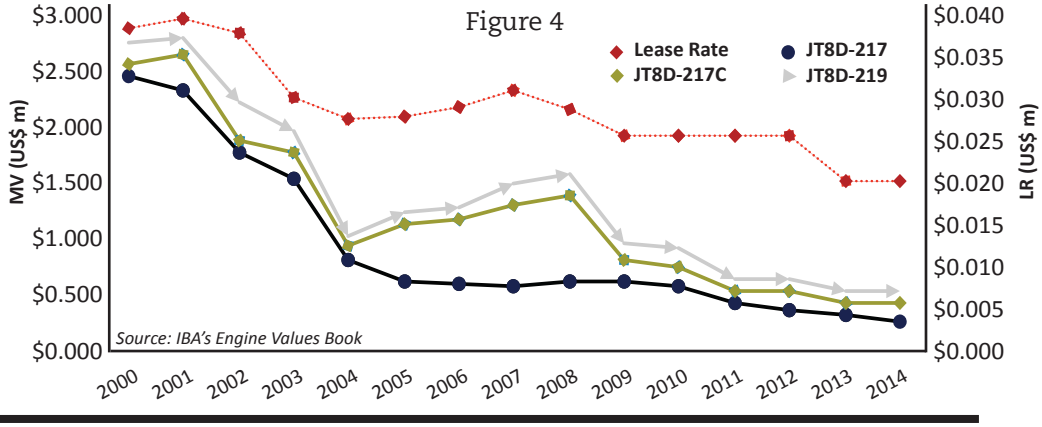
Mature engine operators tend to fall within two categories: larger operators which have owned the aircraft since it was built – ie, American Airlines or Delta Airlines – and smaller operators leasing cheaper older aircraft.

These larger operators tend to maintain the aircraft and engines in house with large stockpiles of spares that they can use to lower maintenance costs as far as possible, which is helped because some have a large maintenance arm. These operators can generate significant demand for the parts they require through their own operations and especially for engine components that still demand a premium.

The second option, but still important to the market's survival, are the smaller operators with anywhere from one to 10 mature aircraft and engines that they operate at minimal possible cost. These operators inherit the retired/placed aircraft from larger/other operators and do whatever is required to keep them serviceable, usually through the purchase of engines or LLPs to increase the remaining cycle limit until the next change is needed.

The key party in the past 10 to 15 years has been the aircraft and engine breakers, which have traditionally torn down aircraft and engine stock to find the parts of most value to the market. With increased OEM influence expected for the new crop of aircraft and engines, many are suggesting that such aftermarket activity might have a shelf life as these aircraft/engines progress through the different phases of maturity.

Figure 4



Source: IBA's Engine Values Book

AIRCRAFT ENGINE OPTIONS 2015

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.

IBA AIRCRAFT ENGINE VALUES 2015

Engine	Fair market value ($m)	Base Value ($m)	Monthly rental	QEC cost range ($m)	LLP Cost (new) ($m)	Overhaul (ex LLP) ($m)	MTBO	FH:FC (hours)
CFM International								
CFM56-3C1 (23.5)	1.20	1.50	18 - 35	0.25 - 0.20	2.60	1.35	7,000	1.6
CFM56-5B3/P	6.25	6.65	60 - 80	0.89 - 2.40	3.00	2.70	13,000	1.7
CFM56-5B4/3	6.65	6.80	60 - 80	0.89 - 2.40	3.00	2.70	19,000	1.7
CFM56-5B6/P	4.65	4.85	60 - 80	0.89 - 2.40	3.00	2.70	18,000	1.7
CFM56-5B5/3	4.98	5.10	60 - 80	0.89 - 2.40	3.00	2.70	20,000	1.7
CFM56-5C4/P	3.65	4.10	40 - 60	0.60 - 1.20	3.10	2.55	15,000	6.0
CFM56-7B20	4.2	4.28	45 - 70	0.40 - 1.50	2.90	2.80	20,500	1.8
CFM56-7B22	6.65	4.72	45 - 70	0.40 - 1.50	2.90	2.80	18,500	1.8
CFM56-7B24	5.4	5.50	45 - 70	0.40 - 1.50	2.90	2.80	17,000	1.8
CFM56-7B26/3	6.65	6.70	64 - 83	0.40 - 1.50	2.90	2.80	18,000	1.8
CFM56-7B27/3	6.95	6.99	64 - 83	0.40 - 1.50	2.90	2.80	17,000	1.8
General Electric								
CF34-3B1	1.25	1.60	20 - 30	0.19 - 0.80	1.60	0.90	12,000	1.3
CF34-8E5	3.35	3.35	35 - 43	0.50 - 0.90	2.45	1.13	11,000	1.3
CF34-10E6	5.15	5.15	53 - 78	0.80 - 1.60	2.05	1.45	16,000	1.3
CF6-80C2B6F	3.40	4.00	45 - 65	0.30 - 0.80	6.35	2.68	15,000	6.0
CF6-80E1A3	10.20	10.20	90 - 125	1.20 - 2.50	9.25	3.70	18,000	5.0
GE90-115BL	24.25	24.25	190 - 280	0.70 - 2.10	10.80	8.00	19,000	6.5
International Aero Engines								
V2522-A5	4.18	4.23	50 - 80	1.00 - 2.50	3.00	2.90	21,000	2.0
V2524-A5	4.68	4.73	50 - 80	1.00 - 2.50	3.00	2.90	19,500	2.0
V2527-A5	5.40	5.67	50 - 80	1.00 - 2.50	3.00	2.90	16,400	2.0
V2533-A5	6.34	6.81	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	10,500	1.5
PW2037	2.40	3.20	35 - 55	0.38 - 1.00	5.30	5.00	18,000	3.0
PW4060	3.40	3.90	50 - 70	0.30 - 1.80	5.70	5.00	18,000	6.0
PW4158	3.00	3.60	40 - 60	0.30 - 1.80	5.70	5.00	10,000	1.8
PW4168A	7.30	8.00	80 - 110	1.40 - 3.20	7.10	5.50	17,000	6.0
PW4090	10.25	10.25	115 - 160	1.00 - 2.50	11.70	11.50	18,000	7.0
Rolls-Royce								
AE3007A1	1.15	1.85	15 - 30	0.085 - 0.30	1.80	1.15	6,500	1.1
RB211-524H-T	2.40	3.65	15 - 40	0.13 - 0.90	5.30	5.50	22,000	8.0
RB211-535E4	3.00	3.70	35 - 50	0.23 - 0.90	4.50	4.20	22,000	3.0
Tay 650-15	1.50	1.50	20 - 30	0.15 - 2.80	1.00	1.20	9,000	1.1
Trent 772B-60	8.00	8.00	95 - 135	2.00	7.10	7.50	25,000	4.5
Trent 970-84	13.85	13.85	120 - 170	0.60	8.00	6.50	25,500	9.0
BR715A1-30	2.45	3.20	30 - 50	0.30 - 0.90	1.75	1.80	9,000	1.6

PILARSKI SAYS...

Engine choice and value retention

Data shows that aircraft retain more value with a greater choice of engines, writes Adam Pilarski, senior vice-president at Avitas.

The question as to the best number of engine options on a new aircraft programme is quite murky but full of deeply emotional disagreements. The is- sues surrounding that question surfaced again as the new A330neo was launched last July with the choice of one engine type or, as we sophisticated analysts say, no choice of engine.

An obvious and important element of the desirability of engine choice is related to the self-interests of those expressing opinions. Who favours which option is easy to predict. Engine manufacturers prefer the choice of only one engine (no choice) because that gives them a monopoly position, which, in accordance to standard economic theory, should maximize their return. Their arguments are based on the premise that the development of a new engine is a very costly proposition – hence, needs to be justly rewarded.

Aircraft manufacturers take a different view. Multiple engine choices are in their best interest because that most likely enlarges the total demand for their product as some airlines are exclusively committed to only one engine manufacturer. Airlines usually are also in favour of choice because that enhances the chance "their" preferred engine provider will be on the programme, plus they, probably, justifiably, believe that competition between engine manufacturers gives airlines more bargaining power and eventually better pricing.

Lessors see benefits to both engine choice and a monopoly position by one producer. Choice enlarges the size of the market for a given product. On the other hand, lessors are interested in as much a vanilla product as possible – ie, if a product sold is very homogenous it is easy to switch between users, while engine choice will undoubtedly split the market and make remarketing of a given aircraft more difficult.

The recent launch of the A330neo provides great examples of such lines of thinking outlined above.

Akbar Al Baker, chief executive officer of Qatar Airways, said he wanted choice of engines. "We have said that to Boeing and Airbus. We want a choice, so airlines are not with their back against the wall."

Steven Udvar-Hazy, chief executive officer of Air Lease Corporation, also wanted an engine option because "the market is big enough for two engine options", while the top executives from other leasing companies such as CIT and Intrepid preferred a single engine option.

Robert Martin, chief executive officer of BOC Aviation, said: "As a lessor I much prefer one engine type. You don't have a split market." And Airbus reluctantly accepted only the Rolls-Royce option, with Tom Williams, then executive vice-president programmes, admitting "we tried hard to have an engine choice".

Obviously, the different players, the manufacturers, operators and owners of aircraft all have different objectives. In a blind voting at the last European Istat meeting in September, 23% of the participants believed that one engine option is best (probably engine manufacturers), 59% favoured two and 18% thought three are preferred (probably airlines).

So, is there an objective way to look at which platform retains its value better – one with more or fewer engine options?

One way to analyze the impact of engine choice on retained value is to look at historical data and attempt to explain the percent value retained by aircraft sold using data collected over many years. A number of factors explain the share of value retained, the most important one being age (aircraft base values depreciate over time) with other variables such as aircraft characteristics, market pen- etration of a given type or the time of sale related

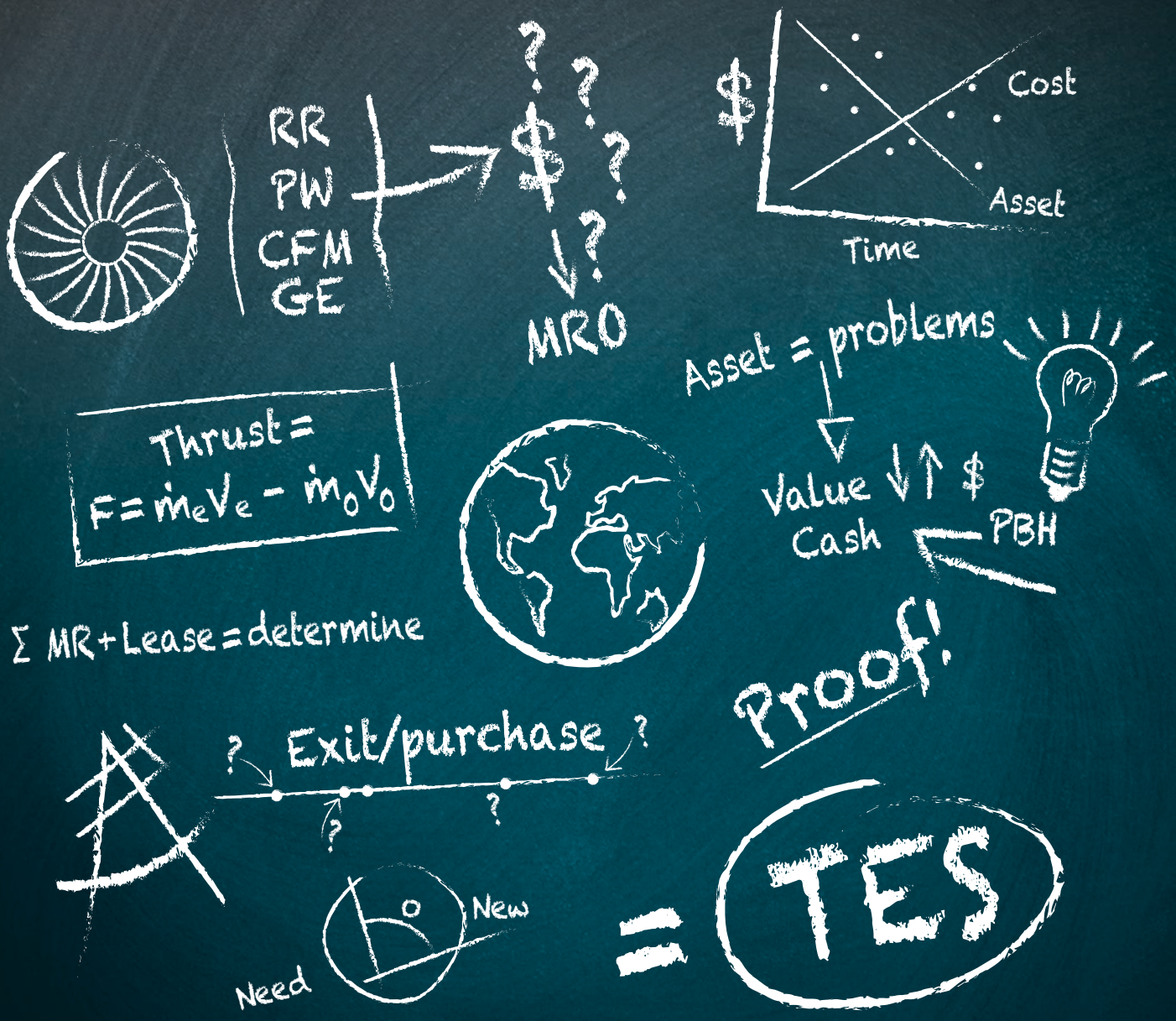
to the phase of the economic cycle also being of importance.

We pooled data for cash sales of all types of narrow- and widebody aircraft from 1970 until 2013. There were more than 2,000 observations for the narrowbody and more than 600 for the widebody aircraft. Overall, narrowbody aircraft produced have a circa two-to-one ratio of those programmes having one versus two engine options. For widebody aircraft the numbers of aircraft produced were much more balanced between the choice of one, two or three engines.

The preliminary results from our research indicate that more engine options enhance the resale value of aircraft, all other factors being held constant. This means that, after controlling for many other relevant variables, an aircraft retained more value if its programme had an engine choice. The quantifications of this added retained value were in single percent terms or about $400,000 to $1 million for narrowbody and about $2.5 million to $3 million for widebody aircraft. These are averages from an initial analysis.

A more comprehensive analysis will produce more accurate numbers but these preliminary results indicate that one of the important constituents (the financiers) suffer when engine choice is limited.

CHALLENGES OF THE ENGINE EQUATION



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