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An *Airfinance Journal* special supplement

Guide to financing and investing in engines 2017

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Mere capital is not enough – technical expertise is also needed

Asian companies such as Sumitomo which have come into the engine leasing space have been wise to pair with more experienced maintenance, repair and overhaul companies such as MTU, writes **Jack Dutton**.

The engine sector has attracted a staggering amount of capital from Asia in recent years, similar to the aircraft leasing market. As we report on page six of this guide, one of the major engine landmarks of the past year came when the Chinese government announced it had launched a new entity, Aeroengine Corporation of China (AECC), an aero-engine company from Beijing which looks to design and build engines that power Chinese-built aircraft.

With a registered capital of Rmb50 billion ($7.5 billion), AECC has already built up a workforce of 96,000. Investors in the company include the Chinese government, the government of Beijing, Aviation Industry Corp of China (AVIC) and Commercial Aircraft Corp of China, according to reports. Aside from that, there is not much more that we know: the company has been reticent so far, refusing to hold many interviews and reveal much about the engines it plans to develop.

China clearly wants to catch up with the West on the engine-producing side, because non-Chinese manufacturers currently power all of its aircraft. The Comac C919 is powered by LEAP-1C engines built by US-French joint venture CFM International, while CF34-10A engines, which are built by US-based GE Aviation, power the AVIC ARJ21 model. But it is likely to be years before the Chinese engine manufacturer makes up any decent market share in an industry already dominated by General Electric, Pratt & Whitney and Rolls-Royce.

When it comes to engine leasing, there is a lot of new investment coming from Asia too. That said, new investors into this space need to be mindful that engine leasing is a very technical business. Cooperation with seasoned lessors and maintenance, repair and overhaul (MRO) companies is necessary to manage and fully understand the asset. Some market observers argue that in engine leasing, the relationship between the lessor and the airline is more important than in pure aircraft leasing. Lease terms are often much shorter in engine leasing, with airlines leasing engines for six months to two years rather than 12 years. The transition in engine leasing is highly technical – engine transportation and logistics are integral parts of the job.

Some of the more recent investors in this space that have come in from Asia have been cognisant of this, often forming joint ventures with more experienced players. For example, Sumitomo, which we speak to on page 24, has, through Sumisho Aero Engine Lease, teamed up with German MRO company MTU Aero Engines, so MTU can provide it with expertise on the technical side. Along with this, Sumitomo has a 20% stake in MTU Maintenance Lease Services. Even being relatively new to this market, if you have deep enough pockets, you can buy the expertise you need.

Banks looking to finance spare engines need to know the lessors they are working with well. They need to know that their investment is safe and need to be able to trust the lessor to move the unit around and manage it competently. A business with a small engine shop might not be able to move the engine as quickly as the likes of Willis Lease Finance or Engine Lease Finance (ELFC), and banks often do not have teams of technical people who know the asset as well as a lessor would.

Judging by the results of our latest Engine Poll (*see pages 9-12*), investors are getting excited about the newer engines for narrowbodies, such as the LEAP and PW1100, scoring high in residual values, remarketing potential and investor appeal. But despite some concerns that the newer engines will have a negative impact on the residual values of the older types, such as the CFM56 family, their residual values have held up well in the survey. Another concern for operators of the newer technology engines is that these models have not been for their first shop visits yet, so nobody knows how much these engines are going to cost to maintain.

Regardless of the potential ramifications linked to the transition into new engines, there is no question that the demand for leased engines is growing and so is the investor appetite for them. But as with all cycles, not all of these new investors will be in it for the long term: companies are bound to leave the market as and when it suits them, as we saw with Macquarie in 2011, when it sold its engine leasing business to ELFC.

With the establishment of companies such as AECC, it certainly looks like Asia is in engines for the long haul.

JACK DUTTON
Editor,
Airfinance Journal

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Editor
Jack Dutton
+44(0)20 7779 8734
jack.dutton@euromoneyplc.com

Asia finance editor
Michael Allen
+852 2842 6941
michael.allen@euromoneyplc.com

Senior reporter
Joe Kavanagh
+1 212 224 3477
joe.kavanagh@euromoneyplc.com

Consulting editor
Geoff Hearn

Managing director
Laura Mueller
+44 (0)207 779 8278
laura.mueller@euromoneyplc.com

Managing director
Olivier Bonnassies
+44 (0)207 779 8062
olivier.bonnassies@euromoneyplc.com

Group sub editor
Peter Styles Wilson

Advertisement manager
Chris Gardner
+44 (0)20 7779 8231
chris.gardner@euromoneyplc.com

Head of subscription sales
Chris Welding
T: +44 (0) 207 779 8015
chris.welding@euromoneyplc.com

Account manager
Oliver Goodwin
T: +44 (0) 20 7779 8868
E: oliver.goodwin@euromoneyplc.com

Senior marketing executive
Sam Fairburn
+44(0) 20 7779 8257
samuel.fairburn@euromoneyplc.com

Managing director, The Ariline Analyst
Mike Duff
+44 (0)20 7779 8058
mduff@theairlineanalyst.com

Divisional director
Danny Williams

Production editor
Tim Huxford

Subscriptions / Conferences Hotline
+44 (0)20 7779 8999 / +1 212 224 3570
hotline@euromoneyplc.com

Customer Services
+44 (0)20 7779 8610
8 Bouverie Street, London, EC4Y 8AX

Directors: John Botts (Chairman), Andrew Rashbass (CEO), Sir Patrick Sergeant, The Viscount Rothermere, Colin Jones, Paul Zwillenberg, David Pritchard, Andrew Ballingal, Tristan Hillgarth

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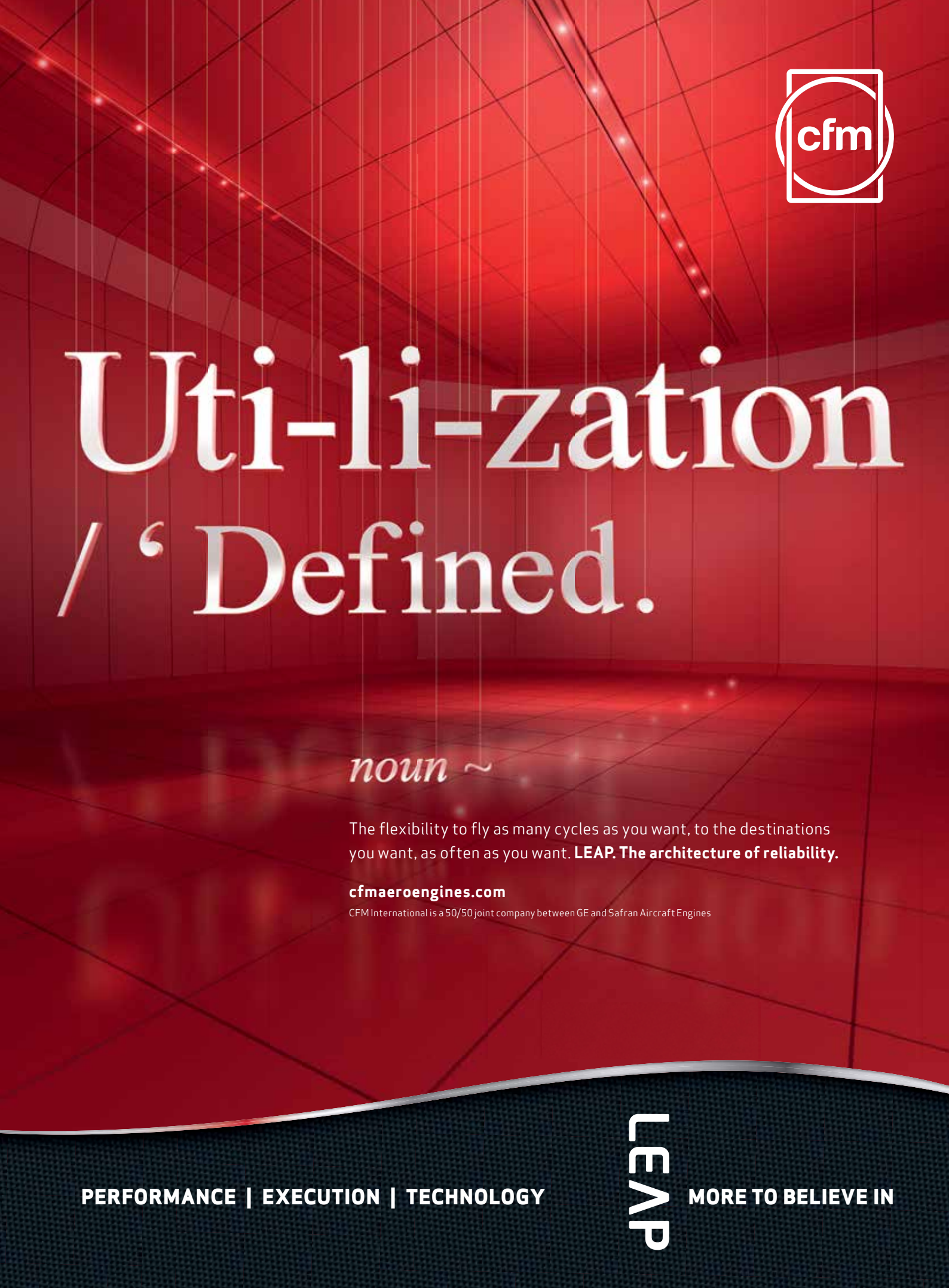
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CFM International names new CEO

Engine manufacturer CFM International has named Gaël Méheust as its new president and chief executive officer.

Méheust replaces Jean-Paul Ebanga, who had served in the role since February 2011 and has moved to another position within Safran. CFM is a 50-50 joint company between GE and Safran Aircraft Engines.

In his new position, Méheust will serve as the company's global representative in its relationships with customers, government agencies, industry associations and the media. He will provide corporate leadership for the integrated management of the joint company, as well as serve as a key interface between the top management levels at GE and Safran. He will also have responsibility for the worldwide brand awareness and reputation of CFM.

Méheust joined Hispano-Suiza (now part of Snecma) in 1984. In 1995, he became part of the commercial engine sales team, with responsibility for key European accounts. Three years later, he was appointed CF6-80 engine programme vice-president, with sales responsibility for all large turbofan engine programmes.

In 2001, he was named Snecma's CFM representative with Airbus in Toulouse, France, followed in 2003 by his appointment as general manager of Airbus Programs at Safran corporate level.

Gaël Méheust, president and chief executive officer, CFM International

From September 2007 until March 2010, Méheust headed the France and UK engineering business units for Labinal.

In March 2010, he was named to his most recent post as executive vice-president of sales and marketing for Safran Aircraft Engines. In this role, he helped launch the LEAP engine programme. The engine has accumulated almost 11,600 orders.

UKEF details support deal for Rolls-Royce-powered 787s

UK Export Finance (UKEF) continues to show support for the aerospace sector and could step up guarantees for Rolls-Royce-powered Boeing 787 aircraft in 2017, after working with US Export-Import bank (Ex-Im Bank) on engine overhauls in 2016.

"Last year was good. We got quite creative and worked with the US Export-Import on overhauls as it made a lot of sense for the both of us," said Paul Walsh, head of business group, aerospace, UKEF, speaking at *Airfinance Journal*'s Global Airfinance Conference in Dublin.

He adds: "Going forward, obviously, we are here to help UK exporters, and one of whom is Rolls-Royce... so in a rather strange 2017 could the UKEF do a Boeing-Rolls-Royce combination before we do an Airbus?"

Support for the 787 would be a welcome move for Boeing. Ex-Im Bank has been operating with just two board members for nearly 19 months, one board member shy of the three needed to approve transactions greater than $10 million.

While UKEF does not have the remit to support Boeing or US imports, "the way in", says Walsh, is through Rolls-Royce, a UK manufacturer, and with an airframe plus engine package that carries "more than 20% UK content".

UKEF already had the authority to reinsure Ex-Im Bank for Boeing aircraft deliveries as long as the units are equipped with Rolls-Royce engines, he adds.

Walsh indicates that UKEF would want Ex-Im Bank involved on any 787 transactions, particularly if a deal involves an existing Boeing customer.

"It makes sense for us, as we value their participation, and it makes sense for them," he says.

Robert Roy, vice-president, transportation division, Ex-Im Bank, also speaking at the Dublin event, says manufacturers have to "become creative in this current time" until Ex-Im Bank "comes back online".

Roy anticipates some "interesting things" are due to come out of financing markets, based on discussions he has had with Boeing Capital.

"They [Boeing Capital] are very motivated to look at different avenues of finance," he says.

In October, LOT Polish Airlines issued a request for proposals for the financing of two Boeing 787 aircraft with UKEF guarantees. The aircraft are due for delivery this summer.

China launches aircraft engine manufacturer

China has launched a state-owned aircraft engine manufacturer to rival Pratt & Whitney, General Electric and Rolls-Royce, according to local media reports.

The state-owned Aeroengine Corporation of China was formally established with about Rmb50 billion ($7.5 billion) in registered capital.

Investors include China's cabinet, the government of Beijing, the Aviation Industry Corp of China (AVIC) and the Commercial Aircraft Corp of China, reports state.

With about 96,000 employees, the new company will focus on the design, manufacture and testing of aircraft engines.

China intends disrupting the duopoly enjoyed by Boeing and Airbus with its own domestically produced aircraft. The Comac C919 is a narrowbody that is planned to enter service in 2019 to rival the Boeing 737 Max and the Airbus A320neo. However, the aircraft will be powered by CFM International's LEAP-1C turbofan engine.

Meanwhile, Comac's ARJ21, a regional jet that entered service in June 2016, is powered by General Electric CF34s.

R-R launches LessorCare

Rolls-Royce (R-R) has introduced LessorCare to the leasing community as part of the wide range of services offered by the manufacturer.

LessorCare addresses lessors' needs for a simple and flexible service offering, says Rolls-Royce.

"It draws together a range of services under one comprehensive framework, while still allowing lessor customers the opportunity to adapt to the level of service through the life of the engine," states the manufacturer.

Rolls-Royce is working in collaboration with AerCap on the design and introduction of LessorCare, in advance of rolling it out to the wider lessor community later this year.

Under LessorCare, customers will sign one agreement covering all Rolls-Royce Trent engine types. This agreement will cover all the services they require, including:

- Customer support – providing lessors with access to Rolls-Royce's network of technical support, publications and training, to optimise responsiveness and keep aircraft-earning revenue.
- Transitions services – giving lessors access to a range of maintenance and availability services, to ensure aircraft move faster and more efficiently between leases. Services include return condition management, remarketing support and maintenance value portability.
- Asset management – Rolls-Royce's experience of working in close partnership with airlines worldwide provides the capability to help lessors maximise engine values through their life-cycle. This includes the incorporation of enhancements to Operating Lessor Engine Restoration Agreements (OPERA) within LessorCare.

Beyond these initial services, Rolls-Royce will continue to work with lessor customers to develop LessorCare, working towards even closer integration between engine services and the lease agreements that lessors have with airlines. This will allow Rolls-Royce and lessors to provide even greater value to their common airline customer during the lease and transition of an aircraft.

"We have been working closely with Rolls-Royce to expand the range of services solutions to offer more choice for owners and operators across the life-cycle," says Aengus Kelly, chief executive officer, AerCap. "We believe that LessorCare is another important step in this journey and we look forward to collaborating further with Rolls-Royce."

Frontier and **ELFC** close LEAP sale and leaseback

US low-cost carrier Frontier Airlines has closed a sale and leaseback deal with Engine Lease Finance (ELFC) for its first CFM LEAP-1A engine. The deal is for a spare engine, the lessor confirms.

Frontier has taken delivery of its first Airbus A320neo, which it is leasing from AerCap.

Source: Frontier

CA-CIB closes engine financing for Latam

Crédit Agricole Corporate and Investment Banking (CA-CIB) has closed a $250 million spare engine facility for Latam Airlines.

The French bank acted as the sole arranger in the transaction. Sumitomo Mitsui Banking and Crédit Industriel et Commercial were participants in the deal.

At the same time, CA-CIB also has detailed loan activities for aircraft financings closed between January and June 2016. The bank closed 47 aircraft transactions worth $5 billion.

Japanese operating leases with call options (Jolcos) and French tax leases dominated the bank's activity between January and June.

French tax leases represented nine transactions in the first five months of the year with different assets, including Airbus A321, Boeing 737-800 and 777-300ER aircraft. In June, CA-CIB closed three additional transactions as arranger and agent.

In the Jolco market, the bank closed deals covering A380, 777-300ER, 787-9 and 737-800 aircraft in the first five months of 2016. CA-CIB was active in transactions for Emirates, KLM, Air France, operating lessor AerCap and Finnair.

Another deal included two A380 units with an undisclosed client.

CA-CIB diversified its aircraft asset exposure through the Jolco transactions with its first A350-900 financing in February.

In June, CA-CIB acted as debt arranger and agent on two additional transactions.

Commercial debt loan structures were limited to one A321 transaction with Vietjet and a 787-9 for the first five months, but in June, CA-CIB added a 737-800 transaction as a senior lender and an A321 as arranger.

The bank also arranged a commercial loan facility on engines for Atlas Air.

It closed finance leases for lessor AWAS on an A320 leased to Aegean Airlines and one 787 unit operated by Ethiopian Airlines.

Two transactions included a 737-800 unit for AerDragon Aviation Leasing for forward lease to Shandong Airlines. The transaction uses a special purpose company established by AerDragon in the Tianjin Free Trade Zone.

CA-CIB and the Korea Development Bank acted as mandated lead arrangers and lenders.

Narrowbodies **stay on top**

Large installed bases and healthy secondary markets are crucial to engine investors, as shown by this year's poll results.

Source: CFM

The LEAP-1B engine scored highly in the poll this year

In many ways, investing in engines follows the same principles as investing in aircraft. Owners want to see a large installed base and a healthy secondary market for their engine type. They like to spread their exposure across a variety of asset types. And they keep an eye on production rates, too, to ensure that the market is not suffering from oversupply and their engines will hold their value later in life.

Where engine investments differ is in the aftermarket. Engines hold their value better than airframes, so by the time some aircraft are about 15 years old, about half the value is contained in the engines that power it (*see chart*). This makes the maintenance, repair and overhaul (MRO) sector for engines even more crucial. If an engine does not have a wide range of buyers of spare parts in the secondary market, its value is dramatically reduced.

The winning engines in this year's poll satisfy the basic needs of investors. The best-performing ones have large installed bases and wide secondary markets. The CFM LEAP family, V2500-A5 and CFM56-7B all have large markets (except the LEAP-1B, which is yet to enter service on the 737 Max, but has attracted a huge orderbook that fills investors with confidence). Meanwhile, the GEnx, the best-performing twin-aisle engine in this year's survey, also has a broad operator base, including many top-tier airlines.

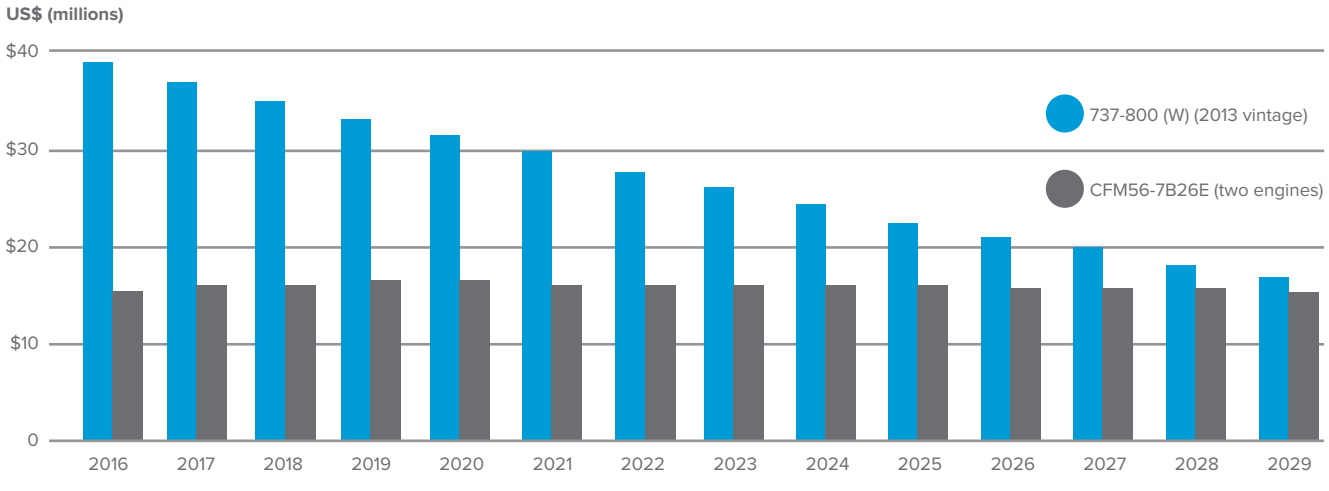
The worst-scoring engines are ones that investors believe have an illiquid market.

> *"Pratt [& Whitney] realised they can't cover the complete GTF market themselves and therefore there have been a few openings on their side. Meaning that they have granted permission to repair the engines to Lufthansa, for example, and MTU, so there are signs that the market is going to be more open than we thought at the beginning."*
>
> **Paolo Lironi**, chief executive officer at SGI Aviation

They are also typically operated by far fewer aircraft. The PW600, for example, which comes bottom for remarketing potential, powers the out-of-production

Total engine value relative to aircraft value

Future base values 2016-2029 at 1.0% inflation (aircraft) and 2.5% inflation (engines)



Source: Avitas

A318. With just 64 of these aircraft in operation, flown by about 20 operators, according to *Airfinance Journal's* Fleet Tracker, the trading market for this engine type is small and shrinking.

Aftermarket control

This year, respondents were still concerned about original equipment manufacturers' (OEM) involvement in the MRO sector on certain aircraft types. However, some also said that certain OEMs have taken steps to address perceived over-involvement.

The long-running dispute comes down to the support packages with which most new engines are sold. Under these arrangements, the engine operator pays a fixed rate for maintenance while the OEM agrees to cover the cost of engine overhauls as and when they are needed. Maintenance agreements allow the manufacturers to recoup extensive development costs for new engines. In response to fierce competition, OEMs often sell engines at cost price or even below, which places even more importance on power-by-the-hour arrangements for OEMs.

Fixed-cost maintenance agreements are very widespread on certain engine types. For Rolls-Royce's Trent engines, for example, the manufacturer controls more than 90% of the engine maintenance.

But engine investors have long been raising concerns about how residual values of some assets are affected by OEM behaviour. By locking down so much of the market for maintenance and repair, these arrangements can take business away from independent MRO providers, by making it difficult for them to compete. This reduces the number of independent MRO shops, and because MRO shops have traditionally accounted for a large part of the demand for spare engines, the result is fewer buyers of spare engines and dampened residual values.

However, Paolo Lironi, chief executive officer at SGI Aviation, argues that OEMs have taken steps to address the problem.

"Pratt [& Whitney] realised they can't cover the complete GTF market themselves and therefore there have been a few openings on their side. Meaning that they have granted permission to repair the engines to Lufthansa, for example, and MTU, so there are signs that the market is going to be more open than we thought at the beginning," he notes.

"Which is definitely good for Pratt, definitely good for operators and definitely good for investors," adds Lironi.

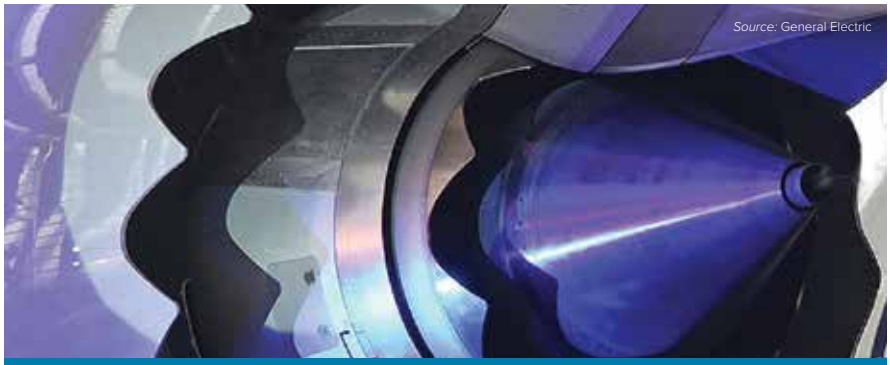
Rolls-Royce has taken similar action but still has work to do to convince the market of its commitment, he says.

"They have tried to come out with solutions about it, [but] they still did not find a proper answer to the market. However, they are focusing on the Trent 700 – whereas there is one engine shop in Abu

Airfinance Journal's 2017 Engine Poll

	Investor appeal (out of 7)	Remarketing potential (out of 7)	Residual value (out of 7)
CF34-8C (CRJ)	3.3	3.4	3.3
CF34-8E (E-Jets)	3.8	4.1	3.7
CF34-10E (E190/195)	4.2	4.4	3.9
CF6-80 (747-400s, 767s)	2.8	3.6	3.3
CFM56-3C (737 Classic)	2.2	2.8	2.3
CFM56-5A (A320)	1.7	1.9	1.4
CFM56-5B (A320)	5.6	5.1	5.6
CFM56-5C (A340)	1.6	1.9	1.4
CFM56-7B (737NG)	6.2	5.9	5.8
CFM Leap-1A	6.2	5.4	5.7
CFM Leap-1B	6.3	5.6	5.8
GE90 (777)	4.3	3.8	3.6
GEnX (787)	5.7	5.1	5.0
GP7200 (A380)	3.1	2.4	2.1
JT9D (747s, 767-200)	0.9	1.6	1.1
PW1100G (A320neo)	5.4	4.4	4.9
PW127F (ATR72-500)	3.6	4.0	4.0
PW127M (ATR72-600)	3.8	4.3	4.4
PW150A (Q400)	3.8	3.9	4.0
PW2000 (757)	2.7	3.3	2.7
PW4000 (747-400s, 767s, 777s)	2.2	3.0	2.7
PW6000 (A318)	1.1	1.2	1.2
RB211-524 (767, 747-300, -400)	1.6	2.0	1.4
RB211-535 (757)	2.7	2.9	2.4
Trent 553 (A340-500)	1.2	1.4	1.3
Trent 556 (A340-600)	1.2	1.3	1.4
Trent 700 (A330)	3.9	3.9	3.9
Trent 800 (777)	2.2	2.5	2.2
Trent 900 (A380)	2.8	2.3	2.3
Trent 1000 (787)	3.9	3.7	3.8
V2500-A1	2.3	2.6	2.3
V2500-A5	6.2	6.2	5.6

Source: Airfinance Journal, May 2017



Source: General Electric

The GEnx engine, which powers the Boeing 787

Dhabi that is now capable of repairing the Trent 700. [It has] limited capabilities, but it's an option – and one option definitely makes a difference," he adds.

However, one respondent raised concerns about the aftermarket for the Trent 700 and pointed out various engine types that are particularly vulnerable to excessive aftermarket control by the OEMs. The GE90 engine, which powers the 777, is a notable offender and the GEnx-1B suffers from the same problem, according to the source.

Manufacturer Ratings

	Ease in financing products (out of 7)	Financial support offered (out of 7)	Product support (out of 7)
CFM	6.0	6.0	5.6
General Electric	5.6	6.0	5.4
IAE	5.0	4.5	4.3
Pratt & Whitney	4.7	4.3	4.3
Rolls-Royce	3.6	4.8	4.7

Source: Airfinance Journal, May 2017

New technology

The market is in the middle of a major shift as new-technology engines enter service. The latest models have obvious implications for current-generation engines. Owners of current-generation assets may have some concerns about how the latest, fuel-efficient engines will affect residual values on older types.

However, the good news, for owners of current-generation types such as the CFM56-7B (on the 737NG), is that the scores of older in-production types have held up well. Despite the incoming arrival of the LEAP-1B, which powers the 737 Max, the -7B has scored highly across the board. With 6.2 out of seven for investor appeal, 5.9 for remarketing potential and 5.8 for residual value (the top score in this category), the engine is holding its value well in the face of dramatic technological change.

Similarly, the -5B variant, the most popular powerplant on the A320, has performed strongly despite the entrance of Neo engines last year. With 5.6 for investor appeal, 5.1 for remarketing potential and 5.6 for residual value, the engine is still an investor favourite.

Of the two engines that power Airbus' A320neo – the CFM LEAP-1A and Pratt & Whitney's PW1100 – the latter is performing worse. Its scores of 5.4 for investor appeal, 4.4 for remarketing potential and 4.9 for residual value are higher than most, but are all behind the equivalent scores for CFM's alternative. This may have something to do with production delays by the engine manufacturer. These have resulted in several operators and lessors so far receiving fewer aircraft than anticipated.

The best-performing widebody engine, the GEnx, is also a relatively new engine. Powering Boeing's 787-8 and 787-9, this engine entered service in 2011 and has been well-received by the market. The other engine type for this aircraft, the Trent 1000, scores less highly across all three categories, suggesting investor concern about the secondary market for the type.

Widebody troubles

Just like aircraft investors, engine investors are typically less attracted to the widebody market. With a smaller installed base and a less-liquid market, the twin-aisle sector is seen as a riskier space to operate.

Widebody engines have typically scored less than those that power single-aisle aircraft in this year's poll, with the exception of the GEnx.

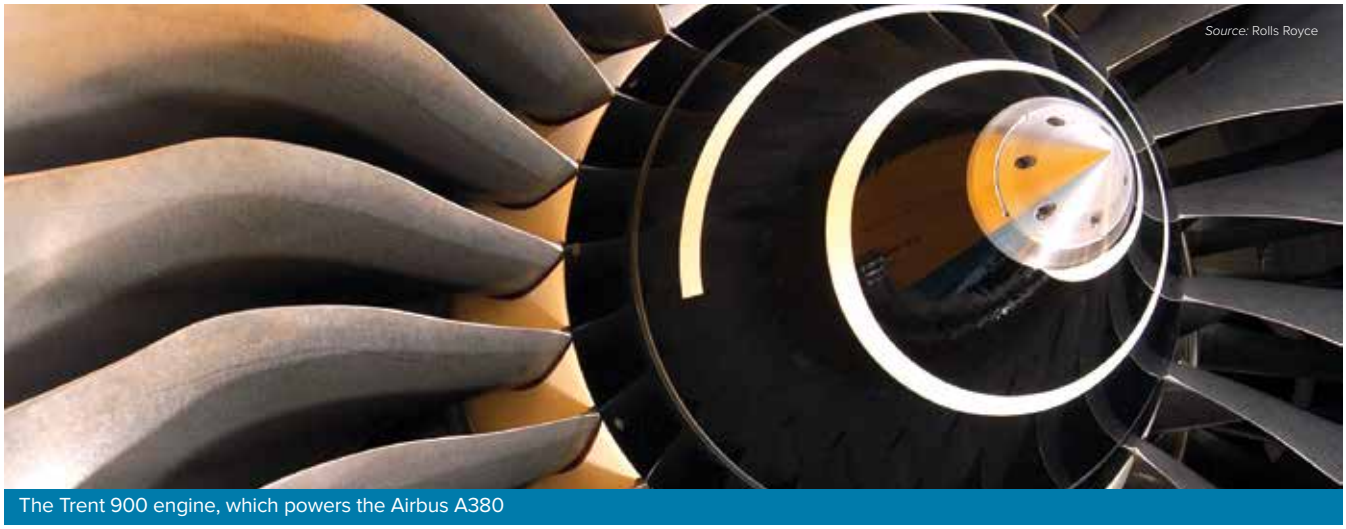
Powerplants on the 747 and A380, in particular, have done badly, reflecting investor concerns about remarketing potential and residual value on those aircraft types. The CF6-80, PW4000 and RB211, for example, which power 747-400s, 767s and 777s have all lagged in this year's poll, with scores ranging between 2.8 and 1.6. The engines powering the A340 models– the CFM56-5C, Trent 553 and Trent 556 – have all performed poorly too.

"One market that is going to be really interesting in 2017 is the Trent 900, installed on the A380," says SGI Aviation's Lironi.

"The first aircraft is coming back in October of this year, and I'm afraid that it is going to be parked. If this aircraft is going to be parked, Rolls-Royce will have four engines not flying. And then you wonder about all the additional aircraft coming back and what is going to happen to all the remaining aircraft coming off lease. So there is potentially a big headache for Rolls," he adds.

Another financier source agrees that the Trent 900 is in trouble. There is, he says, "a tiny operator base entirely wrapped up by the OEM [Rolls-Royce]".

To some extent, the discrepancy between scores of single aisles and twin aisles is to be expected. Because of the smaller installed base and less liquid markets of these engine types, investors can expect twin-aisle aircraft to perform less well for years to come. However, by taking more steps to address investor concerns about the aftermarket, OEMs could do more to make twin-aisle engines a more attractive investment.



Source: Rolls Royce

The Trent 900 engine, which powers the Airbus A380

Demand grows for leased assets

Airfinance Journal and CFM hosted a Financing and Investing in Aircraft Engines roundtable in Tokyo on 8 March. The event's chairman, **Michael Allen**, reflects on its key themes.

At last year's *Airfinance Journal*/CFM Financing and Investing in Aircraft Engines roundtable, Mitsui's Akira Kaido said the demand for leased engines was rising because of the increased use of leased aircraft, increased capital costs for modern engines and operators' desire for more flexibility and more efficient use of working capital.

This year, Kaido's colleague, general manager Tatsuro Okazaki, echoed those comments, saying the engine leasing market is still growing "rapidly".

"The main reason is the growth in the total number of worldwide commercial aircraft and the increased use of leased aircraft, which has an influence on the leased engine market as well" he said.

Okazaki adds that because some engine models are being priced almost twice as high as models being bought 20 years ago that means more airlines rely on lessors' leased engine assets.

This year's event saw delegates from BNP Paribas, BOT Lease, Development Bank of Japan, DVB Bank, IBJ Leasing, K&L Gates, Marubeni Corporation, Mitsubishi Corporation, Mitsubishi UFJ Lease & Finance, Mitsui & Co, PK AirFinance, Shinsei Bank, Showa Leasing, Squire Patton Boggs, Standard Chartered Bank, Sumitomo Corporation, Sumitomo Mitsui Trust Bank, The Bank of Tokyo Mitsubishi-UFJ, Tokyo Century Corporation and White & Case.

Fumika Mikami, aviation finance division, Tokyo Century Corporation, says the event makes her "realise the growth potential of engine leasing/financing deriving from increased demand for spare and replacement needs as airlines all over increase their fleet capacity".

> *"The fact that engines retain value over a longer period of time compared to aircraft given its long useful life makes the asset much more interesting. The point that new technology not only improves reliability but reduces the need for spares was new to me and made me think that I would need to keep up with technological developments as a financier."*
>
> **Fumika Mikami**, Aviation finance division, Tokyo Century Corporation,

She adds: "Furthermore, the fact that engines retain value over a longer period of time compared to aircraft given its long useful life makes the asset much more interesting. The point that new technology not only improves reliability but reduces the need for spares was new to me and made me think that I would need to keep up with technological developments as a financier."

Legal aspects of engine financing

The roundtable saw a panel of lawyers give their thoughts on the legal aspects of aircraft engine leasing.

Tomohiko Kamimura, associate at Squire Patton Boggs' Tokyo office, says that the legal principles of aircraft financing and leasing and engine financing and leasing are "generally very similar", but that the rules differ from country to country.

"There are a few jurisdictions where the title to an engine will merge with the title to an aircraft as a whole, by operation of law – for example, in the Netherlands," says Kamimura. "This is not only an engine lessor's problem, but it is also an engine financier's problem."

Simon Collins, a partner at White & Case Tokyo, says that different jurisdictions pose different challenges for leasing engines.

He adds that engine lessors placing their assets into China will be encouraged by the fact that China has adopted the Cape Town Convention (CTC); however, some uncertainties are nonetheless present.

"Firstly, the CTC remains largely untested there. China also made an opt-out declaration such that the CTC does not apply to internal transactions between PRC [People's Republic of China] parties. Also, China's CTC states you need local court approval before you can exercise your self-help rights – and nobody is terribly clear what that means," he says.

"While the Chinese special administrative region of Hong Kong is very predictable in terms of enforcement and I think people would say it's a commercial and neutral jurisdiction, I guess a concern in mainland China is whether the local party might have a home court advantage."

Squire Patton Boggs' Kamimura says that under Japanese law, it is generally understood that even when an engine is installed on an aircraft, title to the engine will not be automatically merged into title to the aircraft. The engine owner will be able

Airfinance Journal and CFM hosted a Financing and Investing in Aircraft Engines roundtable at The Peninsula hotel, Tokyo

to maintain its title to the engine.

Japan, says Collins, has the issue that once a Japanese airline enters insolvency, a lessor cannot just take its aircraft back.

"Even if you have provisions in your contract which say that the insolvency of the airline is a termination event, you may run into trouble enforcing this in Japan," he explains.

Collins points to the recent corporate restructuring involving Skymark as an example.

"When Skymark entered into corporate restructuring proceedings, that would have triggered a termination right under most – if not all – of their leases. However, Japan – like the US – is a jurisdiction which does not recognise such rights. Any repossession of engines or aircraft would require the approval of the relevant court appointed administrator."

Malaysia presents another interesting case study for aircraft and engine lessors, says Collins, particularly in relation to the restructuring of flag carrier Malaysia Airlines.

"One of the provisions of Cape Town is if the airline is not performing under the lease for a period of 60 days, you are entitled to exercise self-help remedies and repossess your engine or aircraft. But as part of the Malaysia Airlines restructuring, a new law was passed in Malaysia that, among other things, prohibits repossession of assets leased to Malaysian airlines for 12 months following default.

"That would seem to contradict international CTC treaty obligations," says Collins.

"The advice we've seen from Malaysian counsel is that the more recent law is the one that would be followed. This illustrates a political risk with CTC. You may have the protections of Cape Town at the start of the lease, but a change in law could take that away."

Engine leasing in Europe

The conversation did not completely revolve around leasing in Asian jurisdictions.

Sebastian Smith, a partner at K&L Gates Tokyo, says about engine leasing in Denmark: "In deciding whether an engine was permanently installed on an airframe or not, the court took the view that any installation less than three months would probably be considered temporary, and that the engine lessor would need to prove that any period over three months was a temporary installation.

"To this end, Danish counsel's advice should always be sought when documenting Danish engine finance transactions to ensure the engine owner's rights are sufficiently protected."

K&L Gates senior associate Eiko Grieger, who was not a panellist but contributed to the Q&A session, says that since in Denmark's neighbouring country Germany there is no register for aircraft engines or mortgages, one of the key issues for financiers to consider for engine financings in Germany is whether title to the engine transfers to the owner on installation to the airframe.

"Although there is no clear statutory provision in the German civil code on point, German law does distinguish between non-essential parts and essential parts of an aircraft," he says.

"If an engine is considered an essential part, then title to the engine would pass, upon its installation on an airframe, to the owner of such airframe; upon transfer of title of the aircraft to which it is attached, title to the engine would pass to the purchaser of such aircraft. As a consequence, a mortgage over the original airframe would cease to cover the engines once they are installed on another airframe.

Grieger adds: "On the other hand, if an engine is considered a non-essential part, title to such engine would generally remain with the existing owner irrespective of the installation of such engine on another airframe and it would not become subject to a mortgage over the aircraft in favour of a different mortgagee if aircraft and engine are owned by different owners."

His colleague Smith concludes: "As ship engines are legally regarded in Germany as an integral part of the ship and considered essential parts there is an argument to be made that the same rule could be applied to aircraft engines, though said argument is considered weak given aircraft engines can be easily removed from an airframe whereas a ship engine cannot.

"Although the Federal Supreme Court has not specifically dealt with this issue, the prevailing school of thought among German practitioners is to regard aircraft engines as non-essential components."

Overall, delegates showed great interest in the engine leasing market. At least one company in attendance has plans to establish a new engine business, but could not reveal details at this time.

With the influx of new aircraft into the global market, there will be increasing opportunities for Japanese companies to lease and finance engines for airlines.

ANA completes 28% stake in Peach

ANA Holdings has increased its consolidation of the Japanese airline market with its recent purchase of an additional 28.3% stake in Osaka-based low-cow carrier (LCC) Peach, the managing director and head of Tokyo branch of DVB Transport Finance told the Financing and Investing in Aircraft Engines roundtable.

Yoichi Hirotani says that in the past it has been difficult for low-cost carriers under full service carriers to become a success.

The Japanese airline holding company purchased 28.3% of Peach shares from other shareholders First Eastern Aviation Holdings and Innovation Network Corporation of Japan for ¥30.4 billion ($270.9 million).

The parties concluded the share transfer agreement on 24 February. ANA Holdings' overall share in the company has increased to a controlling 67%, up from 38.7%.

"Some media said that this is good or this is bad, but it's probably very difficult to say," says Hirotani.

"Probably the main objective for ANA is to consolidate the profits of Peach. The potential negative side of this is if you look at the full-service airlines and LCC history, people say that LCCs under full-service carriers' operations are probably very difficult to make a success."

Hirotani adds that ANA Holdings' majority stake in Peach would increase ANA's consolidation of the Japanese airline market.

"I'm not saying this is good or not good – I'm telling you the fact," he says.

Hirotani also discussed Ortus Aircraft Leasing Fund, which was established by Sumitomo Mitsui Trust Bank (SMTB) and Novus Aviation Capital in June 2016.

Ortus Aircraft Leasing Fund will purchase aircraft with investor capital and "other finance sources", and lease the aircraft to global airlines, states a statement from SMTB.

The investors will receive dividends based on the cash flow coming from lease rent and sales proceeds of the aircraft.

The fund, which is jointly owned, has a target size of $200 million.

"Probably in Japan most of the institutional investors – regional banks, pension funds, etc – have been trying to look for alternative investment, but it's difficult to find," says Hirotani.

"I hope that this aircraft leasing fund will develop the Japanese equity market and I hope that that's going to be one of the main pillars of the Japanese aircraft investment and financing market."

There's a lot of capital chasing engines

Bobby Janagan, vice-president and general manager at Rolls-Royce & Partners Finance (RRPF), speaks to *Airfinance Journal* about why spare engines are popular investments and how upcoming accountancy rules may impact the market.

***Airfinance Journal:* How has the spare engine leasing market developed over the past few years? How has it changed?**

Bobby Janagan: The spare engine as an asset class has matured – you can see this through the more diverse investors coming into the space. Engines are homogeneous. They retain their value over a longer period of time than aircraft and therefore are much more stable as an asset class, especially as there is an established secondary market for trading. Engines can yield comparatively better returns than aircraft due to their unique characteristics. As a result, diverse investors are showing interest in both narrowbody and widebody engines.

Historically, OEM [original equipment manufacturer]-affiliated lessors had a higher market share in widebody engines, while independent lessors purely focused on more popular narrowbody engine types. Now there is greater competition for narrowbody engines and independent lessors are showing greater interest in widebody engines.

However, what we need to be conscious of is, compared to the aircraft leasing space, the engine leasing space is quite small – the annual deliveries total about $3 billion across all engine OEMs. So it's quite a small market compared to the larger aircraft finance market.

Where are these new investors in engines coming from?

There has been a vertical movement of investors who are familiar with either aircraft leasing from one end of the market or parts traders at the other end of the market moving into spare engine leasing. In addition, banks and private equity investors have entered the space as well. All of these investors are searching for yield and they are being supported by the low interest rate environment and the global glut of capital.

There is a large flow of funds from Asia, mainly Japan and China, into aircraft and engine assets. This flow is disproportionate to the rest of the world except for the USA, which obviously has a deeper reserve of dollar-based capital markets. Lately, Korean investors have invested large sums in single transactions such as the Emirates A380s, as well as a portfolio of aircraft and engines in the GECAS Labrador transaction.

Would you say the engine leasing market has got more competitive?

Yes. The annual quantity of new spare engines delivered by OEMs is relatively small and these assets are popular investments with lots of capital-chasing opportunities. This means yields are lower than they were five years ago. The question is, how long will some of these new investors stay? The interest environment is a factor here: low yields are acceptable in a low interest rate environment but when interest rates rise, these low yields may not be acceptable to the same investors. Also, due to the limited number of assets delivering, the pace of growth for investors may be slower than expected. This means that it may take some time for new entrants to achieve a

scalable platform to profitably manage their assets, particularly widebody engines.

One example is Macquarie. Macquarie started an engine leasing business and, after a few years, they sold the business to Engine Lease Finance because they couldn't scale up the business and instead wanted to purely focus on the aircraft leasing platform. A similar thing could happen with new investors, but I don't know who will be the first to divest from the engine leasing space.

What new options do airlines have now when it comes to leasing engines?

It's not really about new or more options; it is all about understanding the customer and structuring flexible tailored solutions to meet their requirements. As the largest lessor of Rolls-Royce and V2500-A5 spare engines, RRPF has a wide perspective on all of our customers' needs and changing requirements and, as a result, RRPF is able to provide flexible solutions. I think this is what our customers value – our partnership approach to their business challenges.

There is a new accounting rule coming in 2019 called IFRS 16, which basically puts operating leases on the balance sheet as a liability as well as an asset. At the moment, the future liability of rental payments is only a balance sheet note. It's not in the numbers. The new accounting rules will change this and lease rentals will be hard coded into the numbers as a future liability.

With IFRS 16 coming, it may change some of the dynamics of market lease terms – for example, some people may take engines on finance lease terms instead of operating lease terms. But the operating lease market is still going to be there after IFRS 16, as it provides a reliable source of funding, residual risk mitigation and flexibility. The larger lessors are likely to offer tailored solutions to support customers dealing with IFRS 16 but it is premature to discuss the details at this stage.

What new innovations have you seen in the engine leasing market?

If you look at a large lessor like RRPF, we have engines of different maintenance conditions, different ages and therefore different price points, so we can provide a variety of services like green-time lease engines, engine exchanges and acquiring surplus engines which are essential when it comes to fleet transition from one operator to another. This is particularly important when a large fleet fragments into smaller fleet with diverse operators where different operators have different needs. As the largest lessor of Trent 700s and V2500s, RRPF is able to provide such flexible solutions when it comes to these assets.

For example, lessors typically need to transition aircraft from the initial operator to follow-on operators when the aircraft is around 12 to 15 years old. The second lease term is typically five to eight years.

"As the largest lessor of Rolls-Royce and V2500-A5 spare engines, RRPF has a wide perspective on all of our customers' needs and changing requirements and, as a result, RRPF is able to provide flexible solutions."

Bobby Janagan, vice-president and general manager at Rolls-Royce & Partners Finance

The lease terms of follow-on leases are typically linked to aircraft major checks – whether it's a six-year check or a 12-year check – as part of an exit strategy. In this scenario, the aircraft owner will think very carefully about whether to reinvest in significant engine maintenance events. For example, they may want green-time engines, to fly the aircraft all the way to its final check without having to invest in major engine maintenance.

RRPF has closed transactions to help asset owners optimise their specific exit strategy. In the past, during the last major fleet transitions, we couldn't provide that service as we didn't have enough engines, but now we have a critical mass of two engine types, V2500s and Trent 700s, so we can provide tailored solutions.

Any examples of fleet transitions you worked on?

The Trent 700 fleet is still very young, so fleet transitions are only just starting but we have recently helped a lessor to transition some Boeing 777s with Trent 800 engines by providing a green-time engine lease service. This customer needed around seven or eight green-time lease engines over a period of time from a single source. The customer did not want to overhaul the engines because of their investment exit plan, which matched engine retirement to the airframe major checks. We also assisted another lessor by leasing a Trent 800 engine stand to support a transition. Increasingly, RRPF will be able to provide wider asset-based services to support aircraft owners move aircraft.

Is the current low price of jet fuel impacting green-time services?

There may be less demand for green-time lease engine services on some aircraft types. If you look at the A320ceo platform, the life of that platform has been extended as a result of low fuel price. At $100 a barrel, we were expecting the fleet to retire quite sharply. But now, its life has been extended – a lot of aircraft we were expecting to be retired this year are still in service and are going to be in service for some time.

And the current trading price for A320s with leases attached also indicates that A320s or 737s are going to fly for quite a long time. The new aircraft types – the A320neos and 737 Maxs – are going to be used as an incremental capacity because the lower fuel price has stimulated overall demand. The market seems to need both the Ceo and Neo aircraft together.

We've spoken about IFRS 16 and the low fuel prices. From an engine leasing perspective, what do you think are the main challenges the market is facing?

I think the main challenge for the market is to grow profitably. We have seen a lot of media reports about the highly competitive aircraft sale and leaseback market. While we don't see that level of pressure in the engine leasing space yet, there is still strong competition and that is not going to change soon. So the challenge is how to compete and grow profitably.

Secondly, there are a lot of fleet transitions going to happen in the coming years and a larger share of the aircraft will go to untested jurisdictions. While you can and must do legal due diligence before leasing into a new jurisdiction, it is not possible to completely understand how local jurisdictions will respond in practice to distressed situations. In the majority of emerging market jurisdictions the courts can take a long time to give a judgment. We have had experience of this in places such as India. The second major challenge is managing leases in such jurisdictions.

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Carriers spot on with **engine deals**

Two large engine-related transactions featured among the submissions for *Airfinance Journal's* Deal of the Year 2016. Both entries featured two airlines in the Americas: Atlas Air and LATAM.

ATLAS AIR

The Atlas Air transaction featured an unsecured US dollar amortising term loan to finance General Electric GEnx engine Performance Improvement Package (PIP) invoice amounts.

The loan covered a total of eight GEnx-2B engines for Atlas Air's 747-8F fleet. Atlas Air is a launch customer of the 747-8F and has a fleet of 10 747-8Fs.

UK Export Finance (UKEF) acted as the in-house counsel for loan documentation, while Ince & Co was the borrower counsel.

US bank Apple Bank was arranger, agent and sole lender. UKEF and the US Export-Import Bank (Ex-Im) participated as export credit agencies (ECAs) in the term loan, which was mandated in August 2016 and closed on 21 December.

Borrower: Atlas Air
Amount: $48 million
Arranger/lender: Apple Bank
ECAs: UKEF, US Ex-Im Bank
Lawyers: Ince & Co, UKEF in-house counsel
Collateral: Eight GEnx-2B engines

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AWARDS2016
New York Marriot Marquis, 17 May 2017

Deal highlights

The term loan was the first export credit term loan financing for GEnx PIP performance enhancement, which contains engine aerodynamic and structural improvements for the freighter and passenger versions of the aircraft. GEnx is the most efficient engine in aviation covering the 787 and 747-8 models.

"Together with the other improvements made since entry into-service on the 747-8F at the end of 2011, the engine PIP bundles 1.8% with another 1.7% for a total of 3.5% [fuel burn]," says 747-8 chief project engineer Bruce Dickinson.

In addition to drag reduction and improvements to the cruise efficiency of the wing, the empty weight of the 747-8 has been reduced by almost 8,000lbs, while payload-range capability has been boosted through a 12,000lbs increase in maximum take-off weight.

The GEnx-2B67 PIP incorporates an all-new low-pressure turbine, as well as compressor, combustor and turbine improvements derived from the second batch of upgrades (PIP II) devised for the GEnx-1B engine on the 787. General Electric provisionally expected a 1.6% fuel burn improvement but, based on positive test data, increased this to 1.8%. The package of upgrades was launched after predelivery flight tests revealed a fuel burn performance shortfall of more than 2%.

Source: Atlas Air
An Atlas Air 747

Innovation
The transaction has some UK and US content of the GE invoices for PIP improvement which are sufficient for both UKEF and Ex-Im Bank ECA support. General Electric engine products are sourced in Ohio, US, and are installed with UK labour installation content in the General Electric Caledonian factory in Prestwick, Scotland.

New structure
The structure was an unsecured term loan with loan documentation under English law by UKEF in-house counsel with export credit support by UKEF as fronting agency and reinsurance provided by Ex-Im Bank.

Overcoming obstacles
With Ex-Im Bank and European export credit agencies on hold for Boeing and Airbus deliveries, this transaction represented an innovative structure to support the aviation

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sector globally and involve the aviation departments of UKEF and Ex-Im Bank in a significant transaction and aviation investment by Atlas Air.

Complexity

The parties involved in the transaction – Atlas Air/GE/UKEF/Ex-Im Bank/Apple Bank – all worked together in joint cooperation and coordination and, as a result, as smoothly as possible to achieve a new transaction structure during a recent environment for export credit.

LATAM

The LATAM transaction featured a revolving credit facility with a three-year term secured against spare parts, engines, aircraft and routes/slots the borrower owns.

The senior facility was up to $500 million.

Proceeds were used for the company's daily needs and payment of several leases and finances of the fleet.

The revolving credit facility was mandated in January 2016 and closed on 29 March.

Borrower: LATAM Airlines Group
Guarantors: TAM Linhas Aéreas SA and Transporte Aéreo
Structure: Three-year senior facility (revolving credit facility)
Amount: up to $500 million
Collateral: Nine Airbus A320-family aircraft, 20 aircraft engines, more than 500,000 spare parts (from seat belts to landing gears)
Lawyers (and role): Milbank, as counsel to the lenders; Norton Rose Fulbright, as counsel to the borrower; Pinheiro Neto Advogados, as Brazilian counsel; PPU Legal, as Chilean counsel; Morris James, as counsel to the collateral agent
Banks (and role): Citibank, as administrative agent and a lender; Banco del Estado de Chile-New York Branch, as a lender; Bank of America, as a lender; JPMorgan Chase Bank, as a lender; Deutsche Bank-New York Branch, as a lender; BNP Paribas, as a lender; Morgan Stanley Senior Funding, as a lender; Banco Citibank, not as individual capacity but solely Brazilian collateral agent; Wilmington Trust Company, not as individual capacity but solely collateral agent; Deutsche Bank, Banco Alemão acted as Brazilian collateral agent; Natixis, acting through its New York Branch, as a new lender; Credit Suisse-Cayman Island Branch, as a new lender.
Appraiser: ICF International

Deal highlights

Innovation

The transaction was innovative because it represented the first revolving credit facility for Latin America in the aviation sector. It also featured a variety of collateral (aircraft, engines, 500,000-plus spare parts, routes and slots).

The transaction also combined both Cape Town Convention (for aircraft registered in Brazil and engines) and Geneva Convention (spare parts), which required extensive debate with lenders and counsel.

Despite the collateral over the spare parts, LATAM and its affiliates could remain using and replacing spare parts in accordance with its needs, so the list of spares need constant updates.

Complexity

The spare parts are fungible assets under Brazilian law so specific type of security had to be created (fiduciary sale), which differs from mortgages and is mostly common in civil law jurisdictions, while lenders are located in common law jurisdictions.

There was a variety of jurisdictions involved (documents governed by New York law, lenders in New York, borrower in Chile, guarantor in Brazil, operator of aircraft in several Latin American jurisdictions), plus the combination of Cape Town and Geneva conventions.

The spare parts are spread across different countries – Chile, Brazil and the US.

There was the necessity of different security instruments (mortgages, fiduciary sale, pledges, guarantees).

Overcoming obstacles

Some of the aircraft and engines used as collateral were subject to financings and such engines attached to aircraft subject to financing as well, which require a lot of restructuring so they are free and clear of all liens and encumbrances and therefore could be used as collateral.

A lot of parallel and auxiliary work was required in relation to such assets, so the revolving credit facility does not contemplate the loan itself but all the necessary restructurings with multiple banks and lessors.

The appraisal process for the number of spare parts involved was extensive.

The registration requirements in Brazil (particularly for mortgages and fiduciary sales) were extensive and very time consuming, because Brazilian law has a different approach for collateral over aircraft and engines and over spare parts.

The discussions with aviation authorities were required as to confirm that no additional registration would be required with the aeronautical registry for the spare parts.

New structure

The mix of collateral as security for the revolving credit facility in Brazil and Latin America is a new structure, the first of its kind.

Other airlines are interested in the same structure after the LATAM transaction.

Flexibility for the airline

The revolving credit facility provided great flexibility for LATAM and allowed it to allocate capital to its needs and even to pay some of its fleet financing obligations.

The transaction is different from a pure fleet financing (such as an enhanced equipment trust certificate or finance lease), the revolving credit facility gave the airline "free" capital – the structure developed also allowed the airline to replace collateral and have fully operational flexibility, because some of the parts were consumable.

The revolving credit facility was of great value to the airline during a moment of deep economic crisis for Latin American carriers. The banks looked at everything the airline had and that could be used as collateral for the facility (literally everything, because the spare parts comprise screws, seat belts, etc – from small to high value equipment). This was innovative in the region. Granting the airline access to capital allowed the carrier to move forward through the recession.

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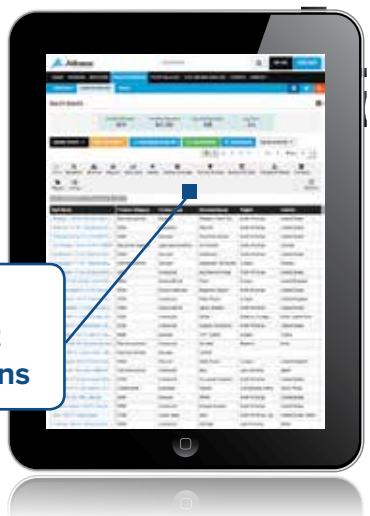

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Production ramp-up should worry OEMs

Jon Sharp, president and chief executive officer of Engine Lease Finance (ELFC) group, shares his views of the engine aftermarket, trends in lease rates and values, as well as the part-out market.

***Airfinance Journal:* What are your observations in the engine aftermarket for 2017?**

Jon Sharp: The production ramp-up for the LEAP and GTF engines poses a massive problem for the respective original equipment manufacturers [OEMs], and with their priority being the supply of engines to the Boeing and Airbus production lines, there are relatively few spare engines being delivered. Add to that the well-documented technical issues experienced by the GTF and all available spares being used by Pratt & Whitney (P&W) to keep that fleet flying, that results in a paucity of sale and leaseback opportunities for engine lessors who focus on the narrowbody types.

Lessors have to rely on the older-generation types for continued growth. However, both the CFM56 and IAE products will be flying for decades yet, and as such provide good opportunities for investors, provided they are purchased at the right price. Those new engine types' technical and production issues will in due course be overcome and lessors can anticipate a huge target market.

Rolls-Royce is further engaging with the leasing community with its new LessorCare product by addressing lessors' needs for a simple and flexible service offering. As an engine lessor, what is your opinion on LessorCare?

We have no experience of this product yet, and therefore I cannot comment from a practical point of view. We are, however, encouraged that Rolls-Royce [R-R] has taken note of the concerns expressed by the leasing community and are now adopting a more sympathetic stance towards them.

We, having largely avoided investing in R-R products over the last decade or so, are now revisiting our strategy and hope to work together with the OEM in investing in some of the products to support their operators.

The OEMs' control of the aftermarket has been an issue. Do you believe that OEM dominance in the aftermarket is a good thing for lessors such as yourself? Or would you prefer to see independent maintenance, repair and overhaul (MRO) shops take back more market share?

The independent MROs have lost approximately half of their market share in a decade. This industry has always thrived on competition. Enough said.

The engine industry is a mature market and the barriers of entry are relatively low, but is the engine leasing market as competitive as the aircraft leasing market?

The barriers to entry may be relatively low but only in financial terms and they are otherwise higher than the aircraft market. One has only to look at how many companies have tried and failed to achieve any sort of critical mass in the engine leasing market. You cannot strategise the acquisition and management of an engine lease portfolio in the same way as you can for aircraft through the analysis of the industry's macroeconomics. The engine market is far more a micro-management exercise, where feet on the ground and specialised technical know-how are at a premium. Metal not money has to be the emphasis. The engine leasing market is hugely competitive: one only has to refer to the lease factors that are achievable,

"The production ramp-up for the LEAP and GTF engines poses a massive problem for the respective OEMs, and with their priority being the supply of engines to the Boeing and Airbus production lines, there are relatively few spare engines being delivered. The well-documented technical issues experienced by the GTF and all available spares being used by P&W to keep that fleet flying, that results in a paucity of sale and leaseback opportunities for engine lessors who focus on the narrowbody types."

Jon Sharp, president and chief executive officer of Engine Lease Finance

which are considerably lower than those for equivalent aircraft.

A small market size, OEM aftermarket control, low lease factors and unpredictable local volatility are the main challenges for engine lessors.

We have seen lots of new investors in the aircraft leasing market, notably from China, over the past few years. Do you see more interest for engines?

We expect a similar cycle. Companies will come and go.

We have seen a softening in lease rates for narrowbody aircraft over the past few years, especially for A320 family and Boeing 737NG models. But lease rates have stabilised and are now improving. How much has the market for the CFM56-5B/7B and V2500-A5 engines been affected? Are lease rates for those engine models now moving up?

We need to separate the two types of market here.

The first is the new equipment sale and leaseback market for engines (typically 10-year lease terms) where there has been little variation in a decade, with lease factors firmly stuck in the 0.6% to 0.7% per month bracket.

The second is the short-term lease or spot market spanning anything from a month to six months; the pricing in that market is wholly a function of supply and demand. For example, the CFM56-7B family of engines has proved so reliable that the available spare engines being offered by 20 or so lessors substantially exceed the demand for the type, so monthly lease rates expressed in dollars are rock-bottom. On the other hand, the V2500 is experiencing an undersupply at present, so lease rates for this type are some 25% higher than the CFM equivalent engine. That will change, of course dependent on factors which have nothing to do with macroeconomics.

Will the part-out market for narrowbodies continue at the same pace this year?

The part-out market, supplying used serviceable material as an alternative to more expensive new OEM parts, is an essential part of the industry structure, particularly for older equipment types. It has grown rapidly over the last few years as investors have been attracted to its returns, with the result that there are today about 70 companies involved in this activity. I believe that number is too many and I have been predicting for a while that the recent too rapid growth will result in casualties as a result of over-valued inventory. Indeed, we have seen several companies go by the wayside of recent. This trend will continue until the industry consolidates, leaving the better managed to survive and prosper.

Are engine lessors sticking to their core engine portfolios or are we seeing a trend for diversifying their portfolio?

Any effective portfolio strategy will provide for a degree of diversification; diversification by engine types, geographical and lessor spread, lease end-date mix and varied product offerings, by which I mean short- and long-term leases, asset management services, engine and parts trading, and so on. This should keep evolving as the market changes.

"In Engine Lease Finance's 27-year history, we have seen the industry affected by wars, epidemics, terrorism and various financial crises but we have always been profitable."

Jon Sharp, president and chief executive officer of Engine Lease Finance

What would happen to the engine leasing market if it we were to enter an economic downturn?

If you have that mixed strategy right, then the effect will be minimised. New entrants will be harmed and a mature portfolio is essential to ride the cycles. In Engine Lease Finance's 27-year history, we have seen the industry affected by wars, epidemics, terrorism and various financial crises but we have always been profitable. Indeed, a downturn, while closing off certain business opportunities, at the same time creates others for the well-placed, well-funded and savvy engine lessor. We expect the next one to be no different for us.

Sumitomo's engine JVs grow cautiously

Michael Allen catches up with Sumitomo Corporation's **Akinori Kojima** about his company's two engine leasing joint ventures (JVs) shortly before he leaves Tokyo for a new assignment in Amsterdam.

A light Dutch twang is discernable in Akinori Kojima's English accent – which is unusual for a Japanese person speaking English. Kojima was seconded from Sumitomo Corporation to aircraft manufacturer Mitsubishi Regional Jet (MRJ) for five years, four of which (2011-2015) he spent in Amsterdam as head of sales and marketing for the Europe, Middle East and Africa (EMEA) region.

Now Kojima, who has spent 27 years with Sumitomo Corporation starting his career in the company's shipping business before moving to the aircraft business in 2001, is preparing to pack his bags again for the Dutch capital for a new assignment. He will become head of Sumitomo Europe and Sumisho Aero Engine Lease's commercial aviation business. His current role in Tokyo is general manager, aircraft and engine leasing department.

"One of the advantages is there is a lot of Japanese companies based in Netherlands. Even though they have their own language, English is widely used," he tells *Airfinance Journal*, adding that geographical convenience and the Netherlands having tax-treaty agreements with "many countries" are other benefits.

Sumitomo Corporation was established in December 1919 and has 24 Japanese and 115 overseas offices in 66 countries. The company has two joint ventures focused on engine leasing. The first, Sumisho Aero Engine Lease (SAEL), is 90% owned by Sumitomo Corporation and 10% by German maintenance, repair and overhaul (MRO) company MTU Aero Engines. The second, MTU Maintenance Lease Services (MTU-MLS), is 20% owned by Sumitomo Corporation and 80% by MTU Aero Engines. Both companies are based in Amsterdam. MTU-MLS has about 30 engines for short-term lease of up to one year and is focused more on emergency leasing, while SAEL has about 40 engines for longer-term lease.

"Sumitomo, engaged with MTU about 10 years ago, starting with some agent business for the MRO business in Japan. We have been supporting such activities in Japan and we have already some business with the Japanese airlines for MRO side," says Kojima.

Akinori Kojima, general manager, aircraft and engine leasing department, Sumitomo Corporation's

"Based on that relationship, in order for both MTU and Sumitomo to expand the engine-related activities we quite naturally discussed about the lease business some years ago. Eventually, we came to the conclusion to have a joint venture for leasing and also part-out businesses."

SAEL has an asset base of about $400 million and focuses on "all different types" of engines.

"We are focusing on engines attached to narrowbody aircraft like Boeing 737 or Airbus A320, but of course not excluding certain popular widebody aircraft engines like GE90 or GEnx. It's easier to place those narrowbody engines – like the aircraft themselves," says Kojima.

He is not "that interested" in regional jet aircraft engines, saying it is more difficult to take advantage of that market because of its smaller size.

SAEL establishes its engine portfolio through sale and leaseback transactions directly with airlines.

"Sometimes we buy the brand-new engines not from manufacturers directly. For example, we bought some engines from SMBC Aviation Capital because they placed speculative orders with Boeing and Airbus and they have a right to purchase the spare engines, so we took those positions and then placed them to certain customers like airlines," says Kojima.

"We also purchased some portfolios from other lessors. We don't deny the possibilities to buy the second-hand engines as well, of course."

Because Sumitomo Corporation also owns 34% of SMBC Aviation Capital, the Irish based lessor will sometimes lease an aircraft and SAEL will provide the engines.

Kojima says that Sumitomo Corporation would like to expand SAEL's engine business, but it depends on "market demand or requirements".

He adds: "It's not easy to become the size of the companies like Engine Lease Finance Corporation [ELFC] and Willis Lease Finance, but we would like to become a very independent engine lessor in this market. We don't have any strict goals."

Kojima says that compared with the aircraft leasing market, the players in the engine leasing market are limited.

"I would say that it is a little bit niche market, so there are OEMs and some mega lessors like ELFC and Willis, followed by us, but not so many as in the aircraft market," he adds.

He says that Sumitomo is "a little bit strong" in funding resources, so is able to compete with the other companies, though he adds: "Of course, the competition at the moment is quite tough like the aircraft leasing market is."

Kojima says: "We lost deals sometimes to other competitors, such as ELFC, whose shareholder is one of the biggest Japanese leasing companies."

Funding for Sumitomo's engine business now comes only from both parent companies – Sumitomo Corporation and MTU – but it is considering looking for third-party funding.

"We cannot provide any names at this stage but believe there are many financial institutions who have interest in this business," says Kojima.

With a return to Amsterdam imminent, Kojima says his goal there will be to use his experience and knowledge to make Sumitomo's commercial aviation business "more solid and strong".

He says: "Europe is one of the biggest markets in this industry, and there are many players – not only leasing and financing but also manufacturing and services sectors – so there will be opportunities to explore any new business with any of our current and potential partners."

Sanad eyes A350

Troy Lambeth, chief executive officer of the Abu Dhabi-based engine and component lessor, speaks to **Jack Dutton** about the complexities of component leasing and what will be his preferred choice of engine in the future.

Unlike many of its rivals, Abu Dhabi-based engine lessor Sanad prides itself on being able to offer component leasing as well as engine leasing.

"In certain cases, customers appreciate the integrated support product – when we show up with engine and component financing but also technical and MRO [maintenance, repair and overhaul] services," Troy Lambeth, Sanad's chief executive tells *Airfinance Journal*.

Launched in 2009, Sanad is wholly owned by Mubadala, the 14th-largest state-owned investment company globally, according to its website. It has about $125 billion-worth of combined total assets.

"Mubadala has a very sophisticated structured finance and capital markets team where they're raising money not only at a bond level from Mubadala but in certain cases supporting assets," says Lambeth. "I think the strength at shareholder level has been key both in size and in speed of execution, both of which have been important for us in certain transactions."

Component complexities

Although engine leasing is a well-trodden path, component leasing is not, because of "significant barriers" that make it more of a challenge for companies to enter, according to Lambeth.

"I think it's one thing for the financial services side of the industry to take a view of long-term aircraft valuation and, of course, making that bankable, and there's a lot of precedents for that, which helps. The engine leasing market is getting a lot of precedents as well and has been for a few decades now."

In component leasing, the securities are different to the likes of aircraft and engines when in most cases you would enjoy an international registry such as the Cape Town Convention.

"You own that serial number of an aircraft or engine whether it's flying or not. With components, the aircraft owner would own anything that's installed on wing," he says.

When Sanad does component leasing in the form of an operating lease, it always owns the component. But that can pose challenges – as a component lessor, you need to understand how to create the right security around the component, says Lambeth.

"You own the off-unit that is now unserviceable, relying on the MRO provider or the airline to return that off-unit rotable to a serviceable standard that is acceptable," he says. "You would not be doing an international registry for the security, so you look at other securities such as a mortgage security or an ownership security."

Lambeth adds: "Understanding the MRO cycle of component maintenance is a very important part of being able to step smartly and do an operating lease for components. There's a lot of technical depth there, structuring depth, and securities depth and you need to be able to offer that product smartly."

Integrated versus non-integrated

Lambeth thinks that more companies are looking to offer integrated products in the engine and component leasing space. He has observed the cycle of this trend on the engine side – from when it has been the flavour of the day to have your engine spares integrated with your engine MRO product to other instances where customers have preferred to have these services separated.

The decision an airline will make in this regard depends on its credit, size and long-term fleet plans, but on the components side, Lambeth is seeing more parties opting for integrated solutions.

"You are seeing more customers have some sort of integrated level of component pooling bundled into their component and MRO programmes, but also having some level of on-site dedicated stock. Whether that's provided by the integrated MRO provider or whether the airline is just holding onto that, we've seen examples of both."

Sanad was initially setup as an enabler to Mubadala's MRO product offering, so it was targeting financings that were linked to integrated MRO programmes. As Sanad grew, it expanded its mandate to include a broader range of support, including both MRO-linked leasing and direct spares leasing. It has helped the company offer value over a broader scale to the market and its customers.

Portfolio and financing opportunities

Sanad's portfolio comprises of a 50-50 balance in value of spare engines and rotable components. Sanad owns 31 spare engines: 11 CFMs, five GE90s, four GEnxs, four GP72720Es, six Trent 500s and one IAE V2500. The lessor has commitments for an additional five engines: one additional GP72720E and four more GEnxs, which will bring up Sanad's total portfolio to 36 engine spares.

"In certain cases, customers appreciate the integrated support product – when we show up with engine and component financing but also technical and MRO [maintenance, repair and overhaul] services."

Troy Lambeth, chief executive, Sanad

Sanad announced its largest-ever transaction in August 2016 – a $265 million deal with Etihad Airways for 12 spare engines: seven GEnx-1B 74/75s, four GP7270Es and one V2527-A5. Of that 12, Sanad closed seven in 2016 – three GEnx engines, three GP70-200s and one V2500s. It has one more GP7270E and four more GEnxs remaining on that commitment.

Sanad and Etihad Airways have worked together on several deals. The first

Sanad's portfolio value split **(engines and components by aircraft type)**

	%	Volume ($ millions)
A330/A340	20-plus	220-plus
777	20-plus	200-plus
A320	20-plus	180-plus
787	15-plus	160-plus
737	15-plus	150-plus
A380	5-plus	80-plus
Others	5-plus	50-plus

Source: Sanad, April 2017

Sanad's portfolio value split **(engine type)**

Engine type	Fleet	%
Trent 500	A340	10
GE90-115B	777	30
GP72720E	A380	15
GEnx-1B 74/75	787	20
IAE V2500	A320	5
CFM56-5B/7B	A320/737	20

Source: Sanad, April 2017

transaction between the parties was signed in 2011 and included the financing of GE90 and Trent spare engines. Additional deals include the financing of rotable component spares in 2013 and, most recently, the addition of GEnx and GP7200 engines and spare landing gear, nacelles, and thrust reversers for the airline's Airbus A380, A330, Boeing 777 and 787 aircraft.

On the component side, Sanad's gross investments are approaching to $600 million. Lambeth says that his company has long-term component leasing pools supporting nearly all modern Airbus and Boeing fleet types. Sanad has components for the A320 family, the A330, A340 and the A380. Lambeth adds that he has his eye on the A350 and Sanad will be entering this market soon. The lessor also has components for Boeing 737-family aircraft, 777s and 787s.

In its first seven years, the company invested more than $1.2 billion in assets. Although Lambeth says he has no specific future growth targets, he wants Sanad to grow at a similar rate.

The airlines Sanad has worked with include Etihad, Virgin Australia, airberlin, Aeromexico, Finnair, Garuda, Ethiopian and others indirectly through the MRO businesses. On the banking side, Sanad has worked with National Bank of Abu Dhabi, FGB, Bank of America Merrill Lynch and, most recently, SMBC.

Some of the airlines in the United Arab Emirates have recently been tapping local banks to help finance their aircraft. Does Sanad look to do the same? "It would depend on the price," says Lambeth. "We're looking for capacity and the right terms. Not surprisingly, early on, we saw a lot of great support from the local banks, but Sanad has grown and valued the diversity.

"We've structured over $900 million in senior asset-backed financings from our lender base. So we'll continue to grow with not only our existing banks but to the extent that it's attractive to us, we'll add more banks."

Future portfolio additions

According to Lambeth, Sanad tends to look at engines and components for assets that are "modern and common". "Modern" meaning the lessor's fleet types that are at least in their first half of production life, not by serial number but by fleet type. "Common" meaning that Sanad will not acquire an asset where there is a concentration risk on one or two customers in the market, but an asset that has a number of customers.

Lambeth says that the A350 fits in both "modern" and "common" categories and he expects the lessor to acquire engines or components for the aircraft in the near future.

"Obviously, there's a number of carriers taking the A350 so we like the fleet type," he says. "A few years ago we were saying the same thing on the 787, and I think today the 787 across engines and rotables represents as much as 30% of our portfolio. Two years ago, we would have been having the same discussion – we didn't have any of those aircraft."

Lambeth has several tips for what he believes will be the engines of the future.

"I believe Sanad will be a big fan of the LEAP – we're already a big fan of the GEnx. You already see us owning four GEnx today and, over the next four years, we've got commitments for four more, so we'll soon own eight GEnx engines."

Lambeth adds that he is also keen on the Gear Turbofan and XWB as an engine type.

"On the components side, you can expect to see Sanad continue in a similar fleet type," he says. "When the [737] Max comes out, we'd expect to participate in component pooling for the Max and then for the Neo, when it comes out on the Airbus side. On the widebody side, you'll see us continue to make investments on the 787 and, as and when the opportunity presents itself, on the A350."

"We've structured over $900 million in senior asset-backed financings from our lender base. So we'll continue to grow with not only our existing banks but to the extent that it's attractive to us, we'll add more banks"

Troy Lambeth, chief executive, Sanad

There's money in maintenance

It is a perceived wisdom in the commercial aircraft market that engine manufacturers make all their money from the aftermarket. This may not be entirely true, but the engine MRO market is big business and the manufacturers are keen to profit.

In an environment of consolidation and low fuel prices, the airline industry continues to be profitable. The International Air Transport Association's 2017 forecast is for profits of about $30 billion on revenues of some $740 billion. Maintenance repair and overhaul (MRO) providers stand to gain from this trend, but taking advantage of the opportunities is far from straightforward.

Various industry sources suggest the current market for commercial aircraft MRO services is worth about $70 billion a year and that this is set to grow beyond $100 billion by 2026. Engine MRO is estimated generally to account for about 40% of the current spend and this percentage is predicted to grow also.

In this context, it is clear why the engine manufacturers are keen to have as much influence as possible in the aftermarket. The plethora of all-inclusive maintenance packages offered by the engine original equipment manufacturers (OEMs) is indicative of this ambition. The various schemes offered vary in detail but, in general, they are refinements of the well-established cost-per-flight-hour contracts offered by the major manufacturers.

The key difference in the latest agreements is the recognition that customer needs change across the lifecycle of an engine and that there are different types of customer, many of whom are focused

on remarketing and residual values. In particular, the needs of aircraft and engine financiers are increasingly being addressed by the manufacturers (*see page 29*).

Many in the industry, particularly airlines and third-party maintenance providers, suggest that the OEMs have too much influence on the aftermarket, with a consequent impact on overhaul and maintenance costs. The engine manufacturers dispute this and say market forces drive the choices of operators to choose all-inclusive schemes, not least because such schemes effectively transfer the risk associated with high-cost maintenance events from the operator to the OEM. Rolls-Royce points out that 90% of its Trent engine fleet is covered by the manufacturer's maintenance scheme, known as TotalCare, but significantly 100% of customers enrolled in the scheme have reselected TotalCare when renewing their fleets.

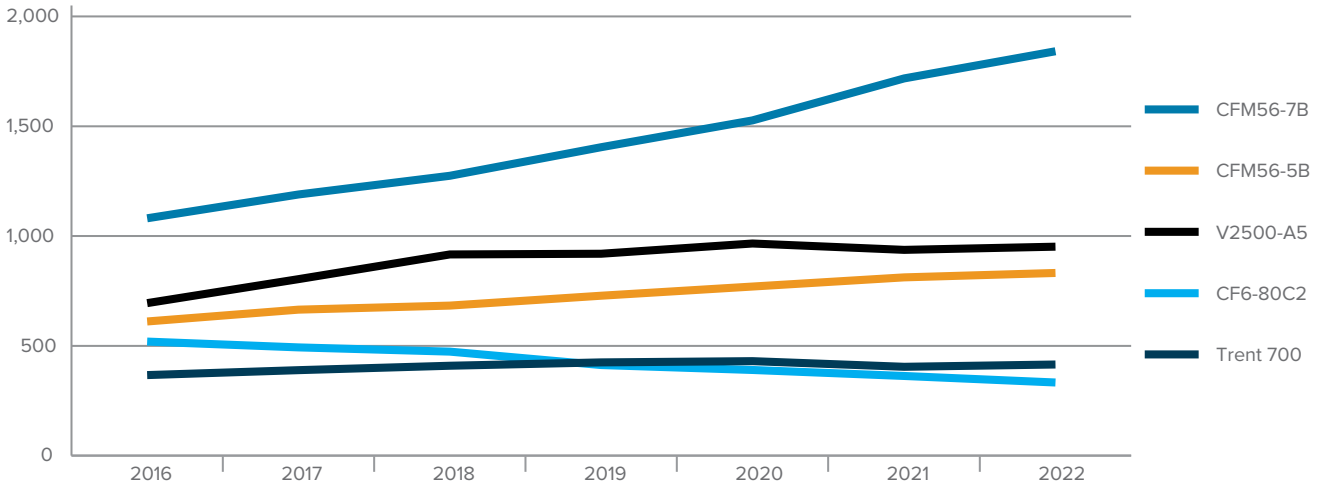
Although many in the industry are sceptical about the role of manufacturers, there is some support for their case. One independent source suggests to *Airfinance Journal*: "You can't have it both ways. If you are not prepared to pay the true cost of the engine upfront then you have to accept that the manufacturers will need to recoup their investments from the aftermarket."

In a recent press briefing attended by *Airfinance Journal*, Rolls-Royce illustrated the challenge faced by manufacturers in managing cash flows. The company pointed out that many of its products, including recent versions of the Trent family, are still in the early phase of their product cycle and it is not until later in the cycle that engines start to provide returns on investment.

Phased approach

Manufacturers also claim that suggestions there is a lack of competition in the engine aftermarket are misplaced because they are usually based on assessments of the engine models that are in the early phases of their product cycle.

Chart 1: 2016-2022 Engine shop visit forecast (key mature engine models forecasted quantity of shop visits)



Source: ICF 2016 Commercial MRO Forecast

It is unquestionably true that manufacturer schemes dominate the maintenance arrangements for new engines – for some engine types, the sign-up rate by new customers is 100%. However, there is a trend away from the all-inclusive schemes as engines mature and then, as engines approach the end of their life (known in the industry as the sunset phase), operators tend to revert to traditional time and materials arrangements, paying for maintenance events as they occur.

Manufacturers have recognised this trend and have developed schemes that cater for more mature engines. Consultancy firm ICF estimates that of about 58,500 engines in service, only some 17% are classified as new in this context, with 55% falling into the mature category and 28% described as in the sunset phase. So engine manufacturers would be missing out a large amount of potential business if they were satisfied with a situation where their maintenance schemes only catered for newer engines.

Third-party prospects

If competition in the aftermarket is to be increased, any expansion of the supplier base is likely to come from third-party sources rather than in-house airline facilities. Industry estimates are in agreement that about 80% of engine maintenance work is outsourced, making it unlikely that airline engine shops will have the capacity to compete with OEM facilities.

There are a number of factors working against third-party providers. Longer engine lives and times between overhauls are decreasing the frequency of shop visits, while the costs of investing in repair capability for newer technology engines is becoming prohibitive.

Genuinely independent shops for the latest technology engines are a rarity, but that may be set to change. In its press briefing, Rolls-Royce alluded to the challenge of growing demand in terms of overhaul shop-visit capacity. The inference from Rolls-Royce's presentation is that requirements for shop-visit capacity are set to grow at a rate that would necessitate a level of capital investment that is likely to exceed the funds available from the OEM.

Some form of independent funding is likely to be required. Whether this can be made an attractive proposition for third-party investors is a challenge, particularly in an environment where 80% of overhaul costs are related to material costs and are therefore dictated by the OEM's spare-part pricing.

Rolls-Royce's predictions on the increasing demand for overhaul capacity are supported by forecasts from ICF, as shown in the charts. Chart 1 shows a steady increase in shop visits for mature engine models over the next few years.

Richard Brown, principal, ICF, says there are a number of key trends to look out for in this context. He says the industry is expecting a wave of narrowbody engine shop-visits but it is not entirely clear when this will occur because engine reliability is such that on-wing times are being pushed to new limits. He adds that it is as yet unclear which MRO shops will benefit and whether there will be significant volumes of business available to independent providers.

As indicated by Chart 2, for the new-technology engine models, there is a predicted surge in shop visits starting about 2023/2024. This surge looks likely for both narrowbody and widebody engines. Brown says that one of the key issues here for OEMs and third-party providers is when to form partnerships, particularly if the popularity of OEM flight-hour contracts continues, as seems likely.

Surplus to requirements

An issue that seems to have receded in importance is that of parts manufacturer approval (PMA) spares. The issue was a cause célèbre in recent years for many independent MROs because they saw the use of such parts as a way of breaking the hold of OEMs, particularly engine manufacturers, on the aftermarket.

Partly because of the resistance of lessors and financiers, the use of PMA parts never gained sufficient momentum to cause any impact on the manufacturers' share of aftermarket sales.

However, there is a successor to the PMA debate. As a result of the increasing trends in aircraft retirements, surplus serviceable material is playing an increasingly important role in engine maintenance. Industry estimates suggest that about 65% of surplus material is engine related.

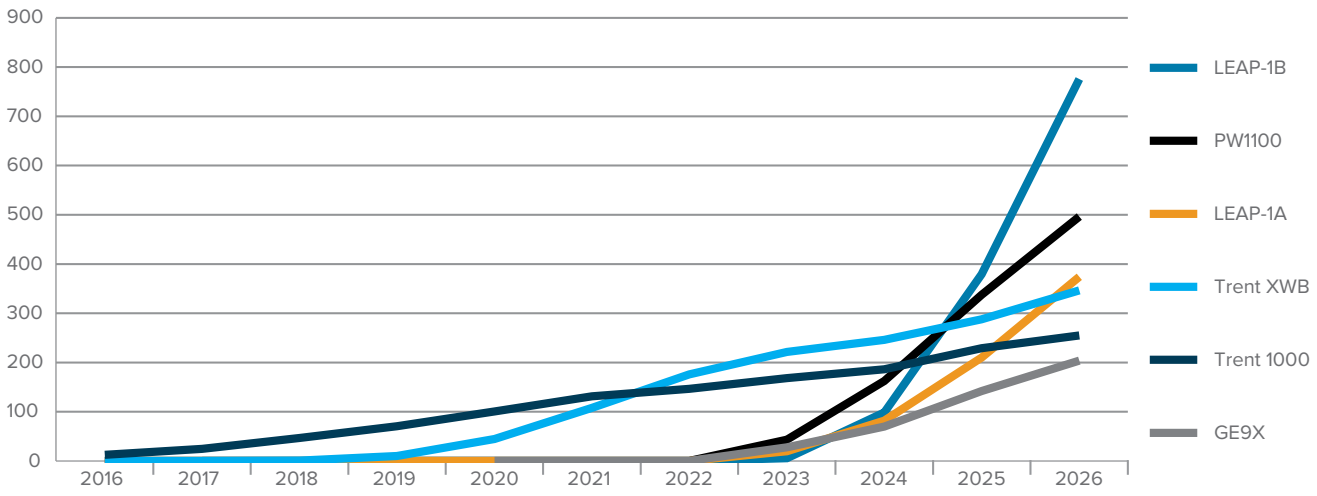
Given that 80% of the cost of an engine overhaul is attributable to replacement parts, the use of such parts can offer significant savings to operators. As a result of this trend, several organisations which specialise in the acquisition and supply of surplus engine parts have sprung up.

This might be seen as a threat to OEMs, but in a world where the manufacturers often have a stake in the values of sunset engines enrolled in maintenance schemes, it is often economic for them to use surplus material and maintain good relationships with the specialist surplus parts companies.

The use of surplus material is, therefore, becoming an important aspect of the engine MRO landscape, and there is an increasing need for funds to support the acquisitions.

This adds a new dimension to the relationship between financiers and the MRO market.

Chart 2: 2016-2022 Engine shop visit forecast (new engine models forecasted quantity of shop visits)



Source: ICF 2016 Commercial MRO Forecast

Rolls-Royce sees increasing value in operating lessors

The manufacturer is targeting the growing lessor community with LessorCare. Rolls-Royce's **Simon Goodson** explains how one agreement covering all Rolls-Royce Trent engine types can address lessors' needs.

Rolls-Royce is further adapting its aftermarket service with newly launched LessorCare targeting a growing market: operating lessors.

The UK-based engine manufacturer introduced LessorCare to the leasing community in January as part of its wide range of services.

Rolls-Royce has pioneered the aftermarket service for commercial aircraft fleets. It launched TotalCare in 1994 and has since introduced more products for its airline customers.

But over the years, it has been criticised by lessors for its grip in the aftermarket business. By directly collecting the maintenance reserves from airlines, TotalCare has limited operating lessors' control over their exposure to the potential workscope of the engine maintenance.

Moreover, operating lessors need flexibility as they move aircraft and engines between customers.

The manufacturer recognises the importance of the lessor community and describes its latest product as a "simple and flexible service offering".

"The world according to aircraft lessors is a rapidly improving space. Most of what lessors need from us is really incredibly straightforward," says Simon Goodson, senior vice-president lessors, civil aerospace, Rolls-Royce.

Goodson says the concept was launched at ISTAT Europe conference in 2015. "More recently, our thinking of all of this space has come under the concept of LessorCare," he adds.

"Why are we doing this? We have spent time with our customers and it is a very simple equation: they are looking for the maintenance life that has been consumed from engines to be there in cash at the right time accessible for them," says Goodson.

Lessors are also looking at the other half of that investment, life yet to be consumed and that can be easily monetisable, he adds.

"We have worked out that the multiple interaction between leasing customers and Rolls-Royce just takes longer than it should. LessorCare is now bringing together that in one simple place," he claims.

Source: Rolls-Royce

Under LessorCare, the engine manufacturer establishes a simple single agreement covering all engine types dramatically reducing the time it takes to contract this with lessors. If we then incorporate the work it has been doing on aircraft transitions and Operating Lessor Engine Restoration Agreements (OPERA), as well as features around asset management, "It makes us much more responsive and ultimately enhances the customer experience dealing with Rolls-Royce," he adds.

> *"The world according to aircraft lessors is a rapidly improving space. Most of what lessors need from us is really incredibly straightforward."*
>
> **Simon Goodson**, senior vice-president lessors, civil aerospace, Rolls-Royce

Goodson says the main idea behind LessorCare is one of simplicity with no loss of flexibility.

"What we are doing is drawing together a range of services under one, simple, agreement covering all Rolls-Royce Trent engine types. This agreement will cover all the services they require, and through that simplification we are looking to streamline the administration that goes into leasing services."

Within LessorCare there are three main elements in the product agreement:

1) Customer support – providing lessors with access to Rolls-Royce's network of technical support, publications and training to optimise responsiveness and keep aircraft earning revenue.

2) Transitions services – giving lessors access to a range of maintenance and availability services, including return condition management, remarketing support and maintenance value portability to ensure aircraft move faster and more efficiently between leases. The services include return condition management, remarketing support and maintenance value portability; all about getting aircraft back into service faster and more efficiently.

3) Asset management – maximising engine values through their life cycle. This includes the incorporation of enhancements to OPERA within LessorCare.

Goodson says the goal of the asset management piece is to provide confidence, allowing the asset to be held for longer.

He is confident that asset management will include a variety of different engine exchanges and greentime leasing solutions.

"We know that at the mature end of the market there will be a requirement for us to have engines that support the TotalCare commitments, to have engines to support TotalCare and TotalCare Flex commitments. Likewise, depending on the lease solution, the lessor may require some engines.

"Ultimately, it is about achieving the residual value of its investment, monetising it. Lessors want the confidence of what is invested has a liquid market attached to it. Liquidity is a critical piece when dealing with high value assets," he adds.

Goodson admits there has been the perception that residual values of Trent-powered aircraft might not be as good as General Electric- or Pratt & Whitney-powered aircraft.

"What we have done is to make sure we can drive confidence in liquidity. There will be a liquid market of these aircraft as they mature. Our mission with asset management is to make sure that, as the asset matures, the lessor is going to monetise its investment. It is an absolute certainty because this is how they make their returns."

"We are drawing together a range of services under one, simple, agreement covering all Rolls-Royce Trent engine types. This will cover all the services they require, and through that simplification we are looking to streamline the administration that goes into leasing services."

Simon Goodson, senior vice-president lessors, civil aerospace, Rolls-Royce

The OPERA scheme is designed to return the lessor to a fully funded position. It provides a fixed price overhaul for the next performance restoration, ensuring a price certainty that the lessor can plan against as the engine returns.

The scheme has been popular. It had 14 customers in 2012 and now has 30 major lessors accounting for 400 engines.

Critics of the scheme point out that while it does address some of the problems surrounding contracts, it does not get around many of the fundamental issues bothering lessors: not least the fact that despite better contracts, return conditions clauses and the OPERA scheme, lessors still do not collect the respective maintenance reserves.

"We have been doing a lot of work with OPERA, that mechanism that moves the value around the system. We expect within the asset management piece to launch an enhanced version of OPERA that allows earlier cash out for maturing aircraft. By doing this, we will give confidence that liquidity will be here, and confidence that they can hold that investment for longer, which is a critical piece in all of this," says Goodson.

LessorCare vision

Rolls-Royce is working with AerCap to develop and introduce LessorCare in the second half of 2017.

"We have AerCap working with us – a key lessor to help us refine this offering with a view to rolling it out to the wider lessor community later this year," says Goodson.

Rolls-Royce expects LessorCare will be available eventually for all of its lessor customers.

"However, as is clear from the amount of positive feedback that we have received from our customers, LessorCare will be extremely popular so we will have to focus our efforts initially on our larger customers," he adds.

Goodson recognises that the operating leasing industry is a "big force" and lessors are getting larger.

In 2005, lessors represented about 16% of the total commercial fleet installed base; today, it is more than one-third. By the time the current orderbook delivers, in the second half of the next decade, operating lessors will represent about half the commercial fleet installed base.

"As lessors get very large, we have a need to constantly evolve. The future vision for LessorCare could potentially include the provision of our services via the lessors," he says.

Goodson sees Rolls-Royce potentially contracting its services with the large leasing entities. "The advantages for us is that lessors would then go distribute commercially the services to a wide number of airlines, operating only few aircraft.

"That could potentially be where the LessorCare goes," he adds.

Lessors cover a whole spectrum of financiers, all the way from very large market forces such as AerCap to single entities. Therefore, there is a huge variety of capability.

"What we know is our business model transition is key to our business and their business model key to them realising the residual value of the investment they invested in. So we give them a help in their remarketing exercise from the outset and access pre-agreed to the many service lines we have," says Goodson.

"LessorCare can be the vehicle for doing transitions very well. We can be best in class for this."

LEAP-1A and **LEAP-1B** engines

With the Boeing 737 Max 8 entering service imminently, CFM International is introducing its LEAP-1B engine. *Airfinance Journal* reviews the LEAP-1A and -1B models.

LEAP-1A

The foundation of CFM International's Leading Edge Aviation Propulsion (LEAP) programme can be found in the success of the CFM56 programme.

CFM International (CFM), the joint venture between GE and Safran Aircraft Engines, officially launched the LEAP engine as the LEAP-X in July 2008. It was presented as a successor to the CFM56-5B and CFM56-7B engines that equip the Airbus A320 current engine option (Ceo) family and the Boeing 737 Next Generation family, respectively.

The three available versions have been selected by Airbus (LEAP-1A to power the Airbus A320neo), Boeing (LEAP-1B for the 737 Max) and COMAC (LEAP-1C to power the C919 models).

The LEAP engine delivers major efficiency benefits for operators of the next generation of single-aisle commercial jets. This includes a 15% reduction in specific fuel consumption versus current-production CFM56 engines. The LEAP engine also promises a 50% cut in nitrogen oxide (NOx) emissions that are about 50% below the International Civil Aviation Organisation's Committee on Aviation Environmental Protection (CAEP/6) limits.

Source: CFM

CFM LEAP-1A engine

Design

The new engine combines advanced aerodynamic design techniques, lighter, more durable materials and leading-edge environmental technologies, making it a major breakthrough in engine technology.

Its design draws on the very best aspects of the CFM56, including exceptional reliability and unrivalled operating costs, as well as low maintenance costs because of optimised engine architecture, making the LEAP the engine of choice for next-generation single-aisle jetliners.

Safran Aircraft Engines developed a new 3D woven carbon fibre composite material for the fan case and blades. Other innovations from Safran Aircraft Engines include the advanced 3D aerodynamic design technique used for the fan blades of the low-pressure section and new stronger, lighter alloys such as titanium aluminide (TiAl) and ML340.

The LEAP engine is more efficient than the CFM56 because it is designed to operate at a higher pressure.

The 3D woven resin transfer molding process used to manufacture the fan blades gives flexibility to the fan blades and hence better resilience than metallic fan blades.

The LEAP engine features a greater use of composite materials, five stages of blisks (blased disks) in the high-pressure compressor, a second-generation Twin Annular Pre Swirl (TAPS II) combustor and a bypass ratio of about 10-11:1.

Ceramic matrix composites are used to build the first stage turbine shrouds.

These technological advances are contributing to produce 15% lower fuel consumption.

Tests programme

CFM had a total of 28 certification engine builds and 32 flight test engines across the three LEAP engine models.

The first engine entering the test programme successfully reached and sustained 33,000lbs (150kN) of thrust, required to satisfy the highest rating for the Airbus A321neo model. It eventually reached 35,000lbs.

GE carried out the first test flight, of a LEAP-1C, with the engine mounted on the company's Boeing 747 flying testbed, in October 2014. The -1C version is a completely integrated propulsion system and features a thrust reverser equipped with a one-piece O-ring replacing a two-piece door.

The thrust reverser is deployed by the O-ring sliding aft, reducing the drag that was induced by the older design and improving efficiency.

The LEAP-1A engine received joint European Aviation Safety Agency and Federal Aviation Administration certification on 20 November 2015. The -1B variant received certification in 2016, while the -1C engine was certified last December.

The LEAP engines provide 22,900 to 32,900lbs-thrust turbofan. The LEAP-1A35A offers 35,000lbs equivalent thrust.

The -1A thrust ratings range from 22,900 to 26,600lbf for the A319neo version.

CFM International has offered two thrust options for the A320neo variant: 24,400lbf and 28,700lbf. Thrust options range from 30,300 to 32,900lbf on the A321neo and A321neo LR versions.

Technical characteristics

Applications	**A319neo**	**A320neo**	**A321neo**
Maximum take-off thrust (lbf)	22,900-26,600	24,400-26,600	30,300-2,900
Bypass ratio	11	11	11
Fan diameter (in)	78	78	78
Number of fan/low-pressure/ high-pressure compressor stages	1+3+10	1+3+10	1+3+10
Number of high-pressure/ low-pressure turbine stages	7+2	7+2	7+2
Entry into service	2019	Aug 16	Q2 2017

Orderbook

CFM International booked 1,801 LEAP engine orders in 2016, 856 of them for the Airbus A320neo family.

CFM has a 55% order share on the A320neo family for aircraft for which an engine selection has been made.

The Asia-Pacific region represented 762 engines orders (381 aircraft) or 90% of the engine manufacturer's intake in 2016.

The Lion Group booked engines for 174 aircraft, followed by AirAsia for 100 aircraft last year.

There were also orders from Asian leasing companies – CDB Leasing (45 aircraft) and CMB Leasing (32 aircraft) – as well as engines for five aircraft ordered by SMBC Aviation Capital.

Lufthansa and TAP Portugal were the winning campaigns in Europe, while CFM International consolidated its presence in South America with an order from Avianca.

Total LEAP orders have now surpassed 12,200 engines and commitments, including spares, representing more than $170 billion at list prices.

On 31 December 2016, CFM International had booked engines for 1,785 aircraft with 32 airline and leasing company customers.

Its top five customers are AirAsia (395 aircraft), Lion Group (174 aircraft), easyJet (130 aircraft), GECAS (120 aircraft) and Frontier/Republic (80 aircraft).

A regional breakdown shows that Asia-Pacific accounts for 781 aircraft orders powered by the LEAP-1A engine or 43.7% of the total orders. Europe accounts for 430 aircraft orders (24.1%), North America 423 (23.7%), Latin America 74 (4.2%), while Middle East and Africa accounts for 77 aircraft orders powered by the LEAP-1A engine (4.3%).

Leasing companies represent about a quarter of the LEAP-1A orderbook with 410 aircraft orders.

North American-based lessors represent 41% of the North American orders, with 173 aircraft units powered by the -1A engine, while European-based leasing companies account for 26.7% of the European orders, with 115 aircraft units powered by the -1A engine.

In Asia-Pacific, lessors represent only 11% of the total Asian orders with 87, while 45 aircraft orders out of 77 are with Middle Eastern lessors.

Production

CFM International began delivering LEAP-1A production engines to Airbus in April 2016 in anticipation of the first A320neo delivery.

The LEAP-1A engine entered service on the first A320neo delivery in August 2016 with Turkey's Pegasus Airlines.

Last year, CFM International delivered 77 LEAP-1A engines, including spares.

According to *Airfinance Journal*'s Fleet Tracker, the engine manufacturer handed over 29 aircraft to customers, as well as spare engines, last year.

Pegasus Airlines was the largest customer with nine units, followed by AirAsia with five aircraft.

Azul Linhas Aereas, Avianca, Frontier and SAS also received LEAP-1A-powered Neo aircraft last year.

Azul and Avianca fleets are under operating lease contracts from AerCap (three aircraft) and GECAS (four aircraft).

SAS's four A320neos received in 2016 were under sale and leaseback deals (two with Standard Chartered Aviation Finance, one with SMBC Aviation Capital and one with Jackson Square Aviation).

Pegasus Airlines' fleet was financed under commercial debt structure with the exception of one unit, which was acquired by GECAS under a sale and leaseback deal.

CFM says it will produce about 500 LEAP engines this year. The LEAP-1B engine was recently certified, paving the way for the entry into service of the Boeing 737 Max models.

LEAP-1A entry into service

The LEAP-1A is doing exceptionally well in service. In March, there were 40 aircraft in operation with nine airlines and the fleet has logged more than 31,000 cycles and 52,000 hours while displaying very mature reliability.

In some instances, carriers have operated up to 11 flights a day, says CFM. The engine is supporting an average gate turn time of 30 minutes, but some operators have reached 25-minute turn times. Overall, the LEAP-1A fleet has a 98% ratio of available days flown, so customers are making great use of the asset.

LEAP-1B engine

CFM International completed the design freeze, a project management technique used for controlling the engineering part of EPC projects, for the advanced LEAP-1B engine, the exclusive powerplant for the Boeing 737 Max family, in May 2013.

This design freeze allowed CFM to finalise and release detailed engine design drawings, eventually leading to build-up of the first engine and testing in mid-2014.

The design freeze for the LEAP-1A/-1C variants was achieved in June 2012.

The LEAP-1B engine is the result of an exhaustive six-year collaboration with Boeing. The entire turbomachinery and installation are customised to meet the unique requirements of the 737 Max.

The 737 Max continues a 36-year relationship between CFM and Boeing; CFM engines have been the sole powerplant for all 737 aircraft sold since 1981. To date, there have been 1,185 firm orders for LEAP-1B-powered 737 Max aircraft.

Ground testing of the LEAP-1B started three days ahead of the original schedule, at Safran Aircraft Engines' Villaroche facility.

The LEAP-1B-powered Boeing 737 Max began flight tests in January 2016, and the engine has performed extremely well in more than 2,200 aircraft flight hours.

The engine offers 737 Max operators exceptional technical, economic and environmental performance, with a 15% reduction in fuel consumption and CO2 emissions versus current engines, a 50% cut in NOx emissions and compliance with the most stringent noise standards (ICAO's Chapter 14 regulations).

CFM achieved engine certification from the European Aviation Safety Agency and the US Federal Aviation Administration (FAA) in May 2016.

The FAA certified the 737 Max 8 aircraft powered by CFM International LEAP-1B engines for commercial service on 9 March 2017, paving the way for commercial service later this year. Boeing is now in the final stages of preparing for the first 737 Max 8 delivery to customers in the coming months.

The LEAP 1-B engine provides 23,000 to 27,900lbs-thrust turbofan. The -1B thrust ratings range from 23,000 to 24,000lbf for the Boeing 737 Max 7 version.

CFM International has offered three thrust options for the 737 Max 8 and Max 200 variants: 25,000lbf, 26,400lbf and 28,700lbf.

On the 737 Max 9 version, two engines are offered: 26,400lbf and 28,700lbf.

Technical characteristics

Applications	**Boeing 737 Max 7, Boeing 737 Max 8, Boeing 737 Max 9**
Maximum takeoff thrust (lbf)	23,000-28,700
Bypass ratio	9
Fan diameter (in)	69
Number of fan/low-pressure/ high-pressure compressor stages	1+3+10
Number of high-pressure/low-pressure turbine stages	2+5
Entry into service	Q2 2017

OEM	Engine	Fair Market Value ($m)	Base Value ($m)	Monthly Rental ($000)	QEC Value Range ($m)	LLP Cost) (new) ($m	Overhaul (ex LLP) ($m)	MTBO	FH:FC
CFM	CFM56-3B1	$0.500m	$0.500m	$0.025m	$0.025 - $0.100	$2.940m	$1.250m	9,000	1.4
CFM	CFM56-3B2	$0.600m	$0.600m	$0.030m	$0.025 - $0.100	$2.940m	$1.300m	8,000	1.4
CFM	CFM56-3C1	$1.060m	$1.060m	$0.035m	$0.025 - $0.100	$2.940m	$1.330m	8,000	1.4
CFM	CFM56-7B22	$4.350m	$4.350m	$0.047m	$0.600 - $1.800	$3.300m	$2.520m	18,000	1.8
CFM	CFM56-7B24	$5.140m	$5.140m	$0.056m	$0.600 - $1.800	$3.300m	$2.520m	17,000	1.8
CFM	CFM56-7B26	$5.880m	$5.880m	$0.065m	$0.600 - $1.800	$3.300m	$2.520m	16,000	1.8
CFM	CFM56-7B24E	$6.560m	$6.560m	$0.060m	$0.600 - $1.800	$3.300m	$2.520m	30,500	1.8
CFM	CFM56-7B26E	$7.430m	$7.430m	$0.070m	$0.600 - $1.800	$3.300m	$2.520m	27,500	1.8
CFM	CFM56-7B27E	$7.730m	$7.730m	$0.080m	$0.600 - $1.800	$3.300m	$2.520m	27,000	1.8
CFM	CFM56-5B5/P	$3.870m	$3.870m	$0.045m	$0.700 - $2.300	$3.400m	$2.720m	17,500	1.7
CFM	CFM56-5B4/P	$5.240m	$5.240m	$0.059m	$0.700 - $2.300	$3.400m	$2.720m	16,000	1.7
CFM	CFM56-5B4/3 PIP	$6.910m	$6.910m	$0.075m	$0.700 - $2.300	$3.400m	$2.720m	28,000	1.7
CFM	CFM56-5B3/P	$5.830m	$5.830m	$0.065m	$0.700 - $2.300	$3.400m	$2.720m	13,500	1.7
CFM	CFM56-5B3/3 PIP	$7.550m	$7.550m	$0.080m	$0.700 - $2.300	$3.400m	$2.720m	25,000	1.7
CFM	CFM56-5C4/P	$2.080m	$1.800m	$0.040m	$0.100 - $0.800	$3.500m	$2.700m	13,500	6.0
EA	GP7200	$10.500m	$10.500m	$0.140m	$1.100 - $1.900	$8.000m	$6.500m	18,000	9.0
GE	CF34-3B1	$1.170m	$1.170m	$0.025m	$0.185 - $0.500	$1.800m	$1.020m	12,000	1.3
GE	CF34-8C5	$2.930m	$2.930m	$0.045m	$0.500 - $0.600	$2.700m	$1.250m	12,000	1.3
GE	CF34-8E5	$3.450m	$3.450m	$0.045m	$0.800 - $0.900	$2.700m	$1.250m	12,000	1.3
GE	CF34-10E6	$5.270m	$5.270m	$0.065m	$1.370 - $1.900	$2.300m	$1.850m	16,000	1.3
GE	CF6-80C2B6F	$2.570m	$2.570m	$0.055m	$0.300 - $0.600	$7.300m	$3.500m	20,000	6.0
GE	GEnx-1B74/74 P2	$18.330m	$18.330m	$0.220m	$1.800 - $4.200	$8.400m	$6.000m	26,500	6.0
GE	CF6-80E1A3	$9.580m	$9.580m	$0.120m	$1.300 - $2.500	$10.500m	$4.200m	19,000	5.5
GE	CF6-80C2D1F	$1.700m	$1.980m	$0.045m	$0.300 - $0.600	$7.300m	$3.500m	20,000	6.0
GE	GE90-115BL	$23.640m	$23.640m	$0.230m	$1.200 - $2.500	$12.350m	$9.000m	21,000	7.5
GE	CF6-80C2B1F	$2.120m	$2.120m	$0.040m	$0.300 - $0.600	$7.300m	$3.500m	22,000	6.0
IAE	V2527-A5	$5.280m	$5.080m	$0.066m	$0.700 - $2.500	$3.600m	$2.800m	16,400	2.0
IAE	V2527-A5 Select	$6.130m	$6.130m	$0.075m	$0.700 - $2.500	$3.600m	$2.800m	22,000	2.0
IAE	V2533-A5	$6.240m	$5.940m	$0.076m	$0.700 - $2.500	$3.600m	$2.800m	11,100	2.0
IAE	V2533-A5 Select	$7.320m	$7.320m	$0.088m	$0.700 - $2.500	$3.600m	$2.800m	14,500	2.0
PW	JT8D-219	$0.550m	$0.550m	$0.020m	$0.070 - $0.080	$2.100m	$1.200m	9,500	1.5
PW	PW4060	$2.400m	$2.460m	$0.042m	$0.300 - $0.600	$6.700m	$5.000m	18,000	6.0
PW	PW4168A	$3.920m	$4.310m	$0.110m	$0.700 - $1.800	$8.500m	$5.700m	17,000	6.0
PW	PW4090	$6.000m	$6.000m	$0.150m	$1.000 - $2.500	$8.500m	$5.700m	18,000	7.0
RR	AE3007	$0.900m	$1.000m	$0.020m	$0.085 - $0.280	$1.850m	$1.500m	8,000	1.1
RR	Tay 650-15	$0.880m	$0.930m	$0.022m	$0.100 - $0.300	$1.500m	$2.250m	9,500	1.1
RR	BR715A	$2.650m	$2.900m	$0.042m	$0.300 - $0.900	$1.900m	$2.300m	12,300	1.1
RR	RB211-535E4	$3.100m	$3.100m	$0.050m	$0.450 - $0.900	$5.100m	$4.450m	22,000	4.0
RR	Trent 1000-J2	$17.120m	$17.120m	$0.190m	N/A	$6.900m	$6.850m	24,000	5.0
RR	Trent 772B-60EP	$8.680m	$8.680m	$0.120m	$2.000 - US$2.050	$8.000m	$8.500m	26,000	4.5
RR	Trent 895	$7.500m	$8.200m	$0.170m	N/A	$10.000m	$8.600m	19,500	5.5
RR	Trent 556-61	$3.550m	$4.730m	$0.110m	$0.200	$8.000m	$6.000m	22,000	8.5
RR	RB211-524T	$1.800m	$1.800m	$0.025m	$0.200 - $0.700	$5.400m	$5.900m	25,000	6.5
RR	Trent 970	$14.070m	$14.070m	$0.170m	$0.600	$9.050m	$6.800m	26,000	9.0

Source: IBA, April 2017

Engine **options 2017**

Aircraft Model	Engine Options
717-200	BR715A1-30
	BR715C1-30
737-300	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
	CFM56-3C1-20K
	CFM56-3C1-22K
737-300QC	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
	CFM56-3C1-20K
	CFM56-3C1-22K
737-300SF	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
	CFM56-3C1-20K
	CFM56-3C1-22K
737-400	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
	CFM56-3C1-20K
	CFM56-3C1-22K
	CFM56-3C1-23.5K
737-400SF	CFM56-3B1
	CFM56-3B2
	CFM56-3C1
	CFM56-3C1-20K
	CFM56-3C1-22K
	CFM56-3C1-23.5K
737-500	CFM56-3B1
	CFM56-3B1-18.5K
	CFM56-3B2
	CFM56-3C1
	CFM56-3C1-18K
	CFM56-3C1-20K
	CFM56-3C1-22K
737-600	CFM56-7B20
	CFM56-7B20/2
	CFM56-7B20/3
	CFM56-7B20E
	CFM56-7B22
	CFM56-7B22/2
	CFM56-7B22/3
	CFM56-7B22E
	CFM56-7B26
	CFM56-7B26/3
	CFM56-7B26E
737-7	LEAP-1B21
	LEAP-1B23
737-700	CFM56-7B20
	CFM56-7B20/2
	CFM56-7B20/3
	CFM56-7B20E
	CFM56-7B22
	CFM56-7B22/2
	CFM56-7B22/3
	CFM56-7B22E
	CFM56-7B24
	CFM56-7B24/2
	CFM56-7B24/3
	CFM56-7B24/3B1
	CFM56-7B24E
	CFM56-7B24E/B1
	CFM56-7B26
	CFM56-7B26/2
	CFM56-7B26/3
	CFM56-7B26E
	CFM56-7B26E/B2
	CFM56-7B26E/B2F
	CFM56-7B26E/F
	CFM56-7B27
	CFM56-7B27/3
737-8	LEAP-1B21
	LEAP-1B23
	LEAP-1B25
	LEAP-1B25C
	LEAP-1B27
	LEAP-1B27C
	LEAP-1B27CB2
	LEAP-1B28
	LEAP-1B28B1
737-800	CFM56-7B24
	CFM56-7B24/2
	CFM56-7B24/3
	CFM56-7B24/3B1
	CFM56-7B24E
	CFM56-7B24E/B1
	CFM56-7B26
	CFM56-7B26/2
	CFM56-7B26/3
	CFM56-7B26/B1
	CFM56-7B26E
	CFM56-7B26E/B2
	CFM56-7B26E/F
	CFM56-7B27
	CFM56-7B27/3
	CFM56-7B27/3B1
	CFM56-7B27/3B1F
	CFM56-7B27/3F
	CFM56-7B27/B1
737-900ER	CFM56-7B26
	CFM56-7B26/3
	CFM56-7B26E
	CFM56-7B26E/F
	CFM56-7B27
	CFM56-7B27/3
	CFM56-7B27E
	CFM56-7B27E/B1
	CFM56-7B27E/B1F
	CFM56-7B27E/F
747-200F	CF6-50E1
	CF6-50E2
	JT9D-7
	JT9D-70A
	JT9D-7A
	JT9D-7AW
	JT9D-7F
	JT9D-7FJ
	JT9D-7FW
	JT9D-7J
	JT9D-7Q
	JT9D-7Q3
	JT9D-7R4G2
	JT9D-7W
	RB211-524B2
	RB211-524C2
	RB211-524D4
747-300	CF6-50E2
	CF6-80C2B1
	JT9D-7R4G2
	RB211-524C2
	RB211-524D4
747-300M	CF6-50E2
	CF6-80C2B1
	JT9D-7R4G2
	RB211-524C2
	RB211-524D4
747-400	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	PW4062
	RB211-524G
	RB211-524G-T
	RB211-524H2
	RB211-524H2-T
747-400BCF	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	PW4062
	RB211-524G
	RB211-524G-T
	RB211-524H2
	RB211-524H2-T
747-400ER	CF6-80C2B5F
	PW4062
747-400ERF	CF6-80C2B1F
	CF6-80C2B5F
	PW4062
	PW4062A
747-400F	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	PW4062
	RB211-524G
	RB211-524G-T
	RB211-524H2
	RB211-524H2-T
747-400ISF	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	PW4062
	RB211-524G
	RB211-524G-T
	RB211-524H2
	RB211-524H2-T
747-400M	CF6-80C2B1F
	CF6-80C2B5F
	PW4056
	RB211-524G
	RB211-524G-T
	RB211-524H2
	RB211-524H2-T
747-8	GEnx-2B67
	GEnx-2B67/P
	GEnx-2B67B
747-8F	GEnx-2B67
	GEnx-2B67/P
	GEnx-2B67B
747SP	JT9D-7A
	JT9D-7AH
	JT9D-7F
	JT9D-7FW
	JT9D-7J
	RB211-524B2
	RB211-524C2
757-200	PW2037
	PW2037M
	PW2040
	RB211-535C
	RB211-535E4
	RB211-535E4-B
757-200 ETOPS	PW2037
	PW2037M
	PW2040
	RB211-535C
	RB211-535E4
	RB211-535E4-B
757-200PCF	PW2037
	PW2037M
	PW2040
	RB211-535C
	RB211-535E4
	RB211-535E4-B
757-200PF	PW2037
	PW2037M
	PW2040
	RB211-535C
	RB211-535E4
	RB211-535E4-B
757-300	PW2040
	PW2043
	RB211-535E4-B
	RB211-535E4-C
767-200	CF6-80A
	CF6-80A2
	CF6-80C2B2F
	JT9D-7R4D
767-200ER	CF6-80A
	CF6-80A2
	CF6-80C2
	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7F
	JT9D-7R4D
	JT9D-7R4E
	JT9D-7R4E4
	PW4052
	PW4056
	PW4060
767-200ERF	CF6-80A
	CF6-80A2
	CF6-80C2
	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7F
	JT9D-7R4D
	JT9D-7R4E
	JT9D-7R4E4
	PW4052
	PW4056
	PW4060
767-200F	CF6-80A
	CF6-80A2
	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
767-300ER	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
	JT9D-7R4D
	PW4052
	PW4056
	PW4060
767-300ERF	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
	JT9D-7R4D
	PW4052
	PW4056
	PW4060
	PW4062
	RB211-524H
	RB211-524H-T
767-300F	CF6-80A2
	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B7F
	JT9D-7R4D
	PW4056
	PW4060
767-400ER	CF6-80C2B7
	CF6-80C2B7F
	CF6-80C2B8F
777-200	GE90-76B
	GE90-85B
	GE90-90B
	PW4077
	PW4084
	TRENT 875
	TRENT 877
	TRENT 884
777-200ER	GE90-85B
	GE90-90B
	GE90-92B
	GE90-94B
	PW4074
	PW4084
	PW4084D
	PW4090
	TRENT 884
	TRENT 890
	TRENT 890B
	TRENT 892
	TRENT 892B
	TRENT 895
777-200LR	GE90-110B1
	GE90-110B1L
	GE90-110B1L1
	GE90-110B1L2
	GE90-115B
	GE90-115BL
	GE90-115BL1
	GE90-115BL2
777-200LRF	GE90-110B1
	GE90-110B1L
	GE90-110B1L1
	GE90-110B1L2
	GE90-115B
	GE90-115BL
	GE90-115BL1
	GE90-115BL2
777-300	PW4090
	PW4098
	TRENT 892
	TRENT 892B
777-300ER	GE90-115B
	GE90-115BL
	GE90-115BL1
	GE90-115BL2
777-8	GE9X
777-9	GE9X
787-10	GEnx-1B64
	GEnx-1B67
	GEnx-1B70
	GEnx-1B70/75
	GEnx-1B74/75
	GEnx-1B76
	GEnx-1B76A/P2
	TRENT 1000-C
	TRENT 1000-D
	TRENT 1000-G
	TRENT 1000-J
	TRENT 1000-M
	TRENT 1000-N
787-8	GEnx-1B54
	GEnx-1B58
	GEnx-1B64
	GENX-1B64 (PIP I)
	GENX-1B64 (PIP II)
	GENX-1B64 (PrePIP)
	GEnx-1B67
	GEnx-1B70
	GEnx-1B70/72
	PW4060
	PW4062
	RB211-524H
	RB211-524H-T
767-300ERF	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
	PW4052
	PW4056
	PW4060
	PW4062
	RB211-524H
767-300 ERF2F	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B4
	CF6-80C2B4F
	CF6-80C2B6
	CF6-80C2B6F
	CF6-80C2B7
	CF6-80C2B7F
	PW4052
	PW4056
	PW4060
	PW4062
	RB211-524H
	RB211-524H-T
767-300F	CF6-80A2
	CF6-80C2B2
	CF6-80C2B2F
	CF6-80C2B7F
	JT9D-7R4D
	PW4056
	PW4060
767-400ER	CF6-80C2B7
	CF6-80C2B7F
	CF6-80C2B8F
777-200	GE90-76B
	GE90-85B
	GE90-90B
	PW4077
	PW4084
	TRENT 875
	TRENT 877
	TRENT 884
777-200ER	GE90-85B
	GE90-90B
	GE90-92B
	GE90-94B
	PW4074
	PW4084
	PW4084D
	PW4090
	TRENT 884
	TRENT 890
	TRENT 890B
	TRENT 892
	TRENT 892B
	TRENT 895
777-200LR	GE90-110B1
	GE90-110B1L
	GE90-110B1L1
	GE90-110B1L2
	GE90-115B
	GE90-115BL
	GE90-115BL1
	GE90-115BL2
777-200LRF	GE90-110B1
	GE90-110B1L
	GE90-110B1L1
	GE90-110B1L2
	GE90-115B
	GE90-115BL
	GE90-115BL1
	GE90-115BL2
777-300	PW4090
	PW4098
	TRENT 892
	TRENT 892B
777-300ER	GE90-115B
	GE90-115BL
	GE90-115BL1
	GE90-115BL2
777-8	GE9X
777-9	GE9X
787-10	GEnx-1B64
	GEnx-1B67
	GEnx-1B70
	GEnx-1B70/75
	GEnx-1B74/75
	GEnx-1B76
	GEnx-1B76A/P2
	TRENT 1000-C
	TRENT 1000-D
	TRENT 1000-G
	TRENT 1000-J
	TRENT 1000-M
	TRENT 1000-N
787-8	GEnx-1B54
	GEnx-1B58
	GEnx-1B64
	GENX-1B64 (PIP I)
	GENX-1B64 (PIP II)
	GENX-1B64 (PrePIP)
	GEnx-1B67
	GEnx-1B70
	GEnx-1B70/72
	GEnx-1B70/75
	TRENT 1000-A
	TRENT 1000-C
	TRENT 1000-D
	TRENT 1000-E
	TRENT 1000-G
	TRENT 1000-H
	TRENT 1000-L
	TRENT 1000-P
787-9	GEnx-1B64
	GEnx-1B67
	GEnx-1B70
	GEnx-1B70/72
	GEnx-1B70/75
	GEnx-1B74/75
	TRENT 1000-A
	TRENT 1000-C
	TRENT 1000-D
	TRENT 1000-G
	TRENT 1000-J
	TRENT 1000-K
	TRENT 1000-Q
A300-600	CF6-80C2A1
	CF6-80C2A3
	CF6-80C2A5
	CF6-80C2A5F
	JT9D-7R4H1
	PW4158
A300-600R	CF6-80C2A5
	CF6-80C2A5F
	PW4158
A300-600RF	CF6-80C2A5
	CF6-80C2A5F
	PW4158
A300B4-200F	CF6-50C2
	CF6-50C2R
	JT9D-59A
A310-200	CF6-80A3
	CF6-80C2A2
	JT9D-7R4D1
	JT9D-7R4E1
A310-300	CF6-80C2A2
	CF6-80C2A8
	JT9D-7R4E1
	PW4152
	PW4156A
A318-100	CFM56-5B8/3
	CFM56-5B8/P
	CFM56-5B9/3
	CFM56-5B9/P
	PW6122A
	PW6124A
A319-100	CFM56-5A4
	CFM56-5A5
	CFM56-5A5/F
	CFM56-5B3/P
	CFM56-5B4/3
	CFM56-5B4/P
	CFM56-5B5
	CFM56-5B5/3
	CFM56-5B5/P
	CFM56-5B6
	CFM56-5B6/2
	CFM56-5B6/2P
	CFM56-5B6/3
	CFM56-5B6/P
	CFM56-5B7/3
	CFM56-5B7/P
	V2522-A5
	V2522-A5
	V2522-A5
	V2524-A5
	V2524-A5
	V2524-A5
	V2527-A5
	V2527-A5
	V2527-A5
	V2527E-A5
	V2527M-A5
	V2527M-A5
	V2527M-A5
A319neo	LEAP-1A24
	LEAP-1A24E1
	LEAP-X
	PW1124G
A320-100	CFM56-5A1
	V2500-A1
A320-200	CFM56-5A1
	CFM56-5A1/F
	CFM56-5A3
	CFM56-5B4
	CFM56-5B4/2P
	CFM56-5B4/3
	CFM56-5B4/3B1
	CFM56-5B4/P
	CFM56-5B5/3
	CFM56-5B6/3
	CFM56-5B6/P
	V2500-A1
	V2527-A5
	V2527-A5
	V2527-A5
	V2527E-A5
	V2527E-A5
	V2527E-A5
	V2530-A5
	V2530-A5
A320-200 pre 1993	CFM56-5A1
	CFM56-5A3
	V2500-A1
A320neo	LEAP-1A26
	LEAP-1A26E1
	LEAP-X
	PW1127G
A321-100	CFM56-5B1
	CFM56-5B1/2P
	CFM56-5B1/3
	CFM56-5B1/P
	CFM56-5B2
	CFM56-5B2/P
	CFM56-5B3
	V2530-A5
A321-200	CFM56-5B1
	CFM56-5B1/2P
	CFM56-5B1/3
	CFM56-5B1/P
	CFM56-5B2
	CFM56-5B2/3
	CFM56-5B2/P
	CFM56-5B3
	CFM56-5B3/2P
	CFM56-5B3/3
	CFM56-5B3/3B1
	CFM56-5B3/P
	V2530-A5
	V2530-A5
	V2530-A5
	V2533-A5
	V2533-A5
	V2533-A5
A321neo	LEAP-1A32
	LEAP-1A32B1
	LEAP-1A32B2
	LEAP-1A33
	LEAP-X
	PW1133G
A330-200	CF6-80E1A2
	CF6-80E1A3
	CF6-80E1A4
	CF6-80E1A4/B
	PW4164
	PW4168A
	PW4170
	TRENT 772B-60
	TRENT 772C-60
A330-200F	CF6-80E1A2
	CF6-80E1A3
	CF6-80E1A4
	CF6-80E1A4/B
	PW4164
	PW4168A
	PW4170
	TRENT 772B-60
	TRENT 772C-60
A330-300 HW	CF6-80E1A3
	CF6-80E1A4
	CF6-80E1A4/B
	PW4168A
	PW4170
	TRENT 772-60
	TRENT 772B-60
	TRENT 772C-60
A330-300 LW	CF6-80E1A2
	CF6-80E1A3
	PW4164
	PW4168
	PW4168A
	TRENT 768-60
	TRENT 772-60
A330-800	TRENT 7000
	TRENT 7000
A330-900	TRENT 7000
	TRENT 7000 TBD
A340-200	CFM56-5C2
	CFM56-5C2/F
	CFM56-5C2/G
	CFM56-5C2/P
	CFM56-5C3
	CFM56-5C3/F
	CFM56-5C3/G
	CFM56-5C3/P
	CFM56-5C4
	CFM56-5C4/P
A340-300	CFM56-5C2
	CFM56-5C2/F
	CFM56-5C2/G
	CFM56-5C2/P
	CFM56-5C3
	CFM56-5C3/F
	CFM56-5C3/G
	CFM56-5C3/P
	CFM56-5C4
	CFM56-5C4/P
A340-500	TRENT 553-61
	TRENT 553A2-61
	TRENT 556-61
	TRENT 556A2-61
A340-600	TRENT 556-61
	TRENT 556A2-61
A350-1000	TRENT XWB-97
A350-900	TRENT XWB-75
	TRENT XWB-84
A380-800	GP7270
	GP7270E
	TRENT 970
	TRENT 972

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