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MRO

Management



Industry voices

Why 2021 could see an MRO recovery

End of life solutions

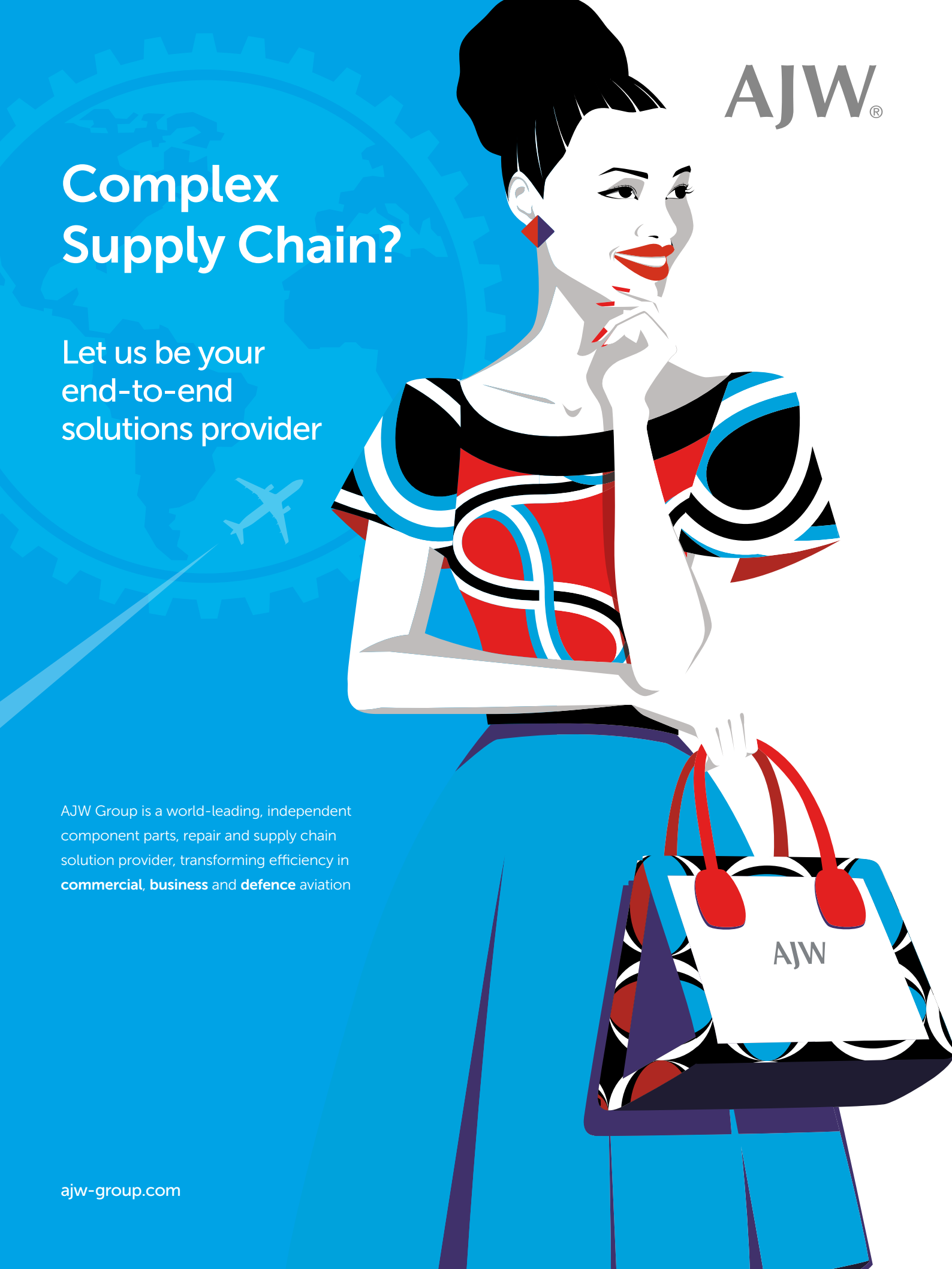
Should an aircraft be parked, stored or recycled?

Software for MRO

Covid crisis drives demand for greater functionality

Sustainable fuel

Scaling up production and driving down costs



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Management

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**KEEP.
IT.
SIMPLE.**

**WHEELS AND BRAKES.
IT'S THAT SIMPLE.**



EDITOR'S LETTER

Welcome to the December 2020 issue of MRO Management. Wherever you are, and whatever has happened to you this year, there's a good chance that at some point you've felt like you were stuck in your own version of the movie Groundhog Day. Days seemingly all the same, in the same place, with plenty of bad news and no way out.

However, with the recent positive developments in Covid-19 vaccine production and distribution, there might just be a way out now – and a return to some sort of normalcy in our lives. There could be a recovery in the MRO sector too in 2021.

In a new section called Industry voices, we bring together the views of leaders and experts in the MRO sector. In the first edition, NAVEO Consultancy managing director Richard Brown explains why the green shoots of recovery are there – and why spring and summer 2021 look to be much healthier.

Another thing about Groundhog Day is that through adversity the main character Phil Connors, played so brilliantly by Bill Murray, learns to appreciate the value of time and the value of others, and to become the best version of himself.

There is much wisdom in the movie we can apply to our own lives, and it seems many companies in the MRO industry are responding to the Covid-19 chaos much like the best version of Phil Connors would. Another contributor to Industry voices, AJW Group chief executive officer Sajedah Rustom, explains how the company turned potential crisis into an opportunity to evolve and re-focus for the future. And in our Top table interview, Lufthansa Technik's Jens Krueger discusses the many post-Covid-19 opportunities he sees in the MRO market.

This issue also includes our regular array of features, interviews and news analysis. It is my first issue as editor and I welcome your thoughts, comments or suggestions as we break free of 2020 – the year of the Covid-19 crisis and of many personal Groundhog Days. But, as the movie shows, there is always hope, and there is always the possibility of turning around any bad situation.

Jason Holland

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HANGAR TALK



AIRCRAFT

New aircraft spend to reach US\$2.8 trillion by 2039

The world will need US\$2.8 trillion worth of new aircraft over the next 20 years despite the impact of the pandemic, according to a report by Cirium.

The 2020 Cirium Fleet Forecast estimates that 43,315 new passenger and freighter aircraft will be delivered between 2020 and 2039.

That represents an eight per cent drop compared to the 20-year outlook in the 2019 forecast, and includes some 4,600 fewer deliveries in the next decade.

Flying hours will also drop 45 per cent in 2020 to 94 million, compared to 170 million in 2019. However, the use of more fuel-efficient aircraft this year means that total CO₂ emissions are likely to fall by 50 per cent.

Asian markets will be the growth engine for the industry during the next two decades

Cirium also predicted that Asian markets will be the growth engine for the industry during the next two decades. China looks to be the biggest single destination for new commercial and passenger aircraft deliveries between 2020 and 2039, with a 22 per cent share.

The share of deliveries to Europe will drop four per cent, to 16 per cent by 2039. This still means that more than 7,000 new aircraft will be delivered over the two decades. Only six per cent of new aircraft will be delivered to the

Middle East – but as these deliveries comprise higher levels of twin-aisle aircraft, the region will account for 10 per cent of the total value of deliveries.

For the forecasted traffic growth to take place, the global passenger fleet will have to increase by just over 20,000 units. That equates to a 2.9 per cent annual growth rate, taking the fleet to some 47,000 aircraft by the end of 2039.

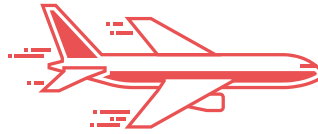
About 82 per cent of the current fleet is also forecast to be retired from passenger service during the 20-year period, with 74 per cent for freighters, which have longer economic useful lives.

There are expected to be more than 21,600 retirements. The freighter fleet will grow almost two per cent annually to reach 4,100 aircraft.



43,315

new aircraft
delivered before 2039



82%

of current fleet to be
retired by 2039



45%

decline in flying
hours in 2020

MAINTENANCE

MTU forecasts strong commercial recovery for 2021

MTU Aero Engines is expecting a strong recovery in commercial maintenance in 2021. At its virtual Capital Market Day, the company said this part of its business would show “the clearest recovery from the effects of the Covid-19 crisis” next year, with revenue growth “in the 20 per cent range”.

As a result, MTU said it would stick to its expansion plans and noted that its spare parts business would also “pick up”, posting “slightly higher” revenue. But revenue from commercial engine manufacturing is expected to remain flat.

“All market analyses indicate that aviation will remain a growth business in

the long term,” said MTU Aero Engines’ CEO Reiner Winkler. “We see the coming years as a restart phase in which we will use our technological leadership, innovative strength and flexibility to extend our good starting position, so that we can derive above-average benefit from the growth of the sector from 2024.”

Michael Schreyögg, chief program officer, said key drivers would be the company’s “strong position in engines for narrowbody aircraft and our large customer base in the cargo sector”.

In commercial spare parts, MTU predicts the main revenue drivers in 2021 will be the V2500 for the A320, the CF6, and the PW2000 for the 757. The company is also working on future technologies, chief operating officer Lars Wagner noted. “We are paying special attention to issues such as emission-free flying, especially topics like hydrogen and flying fuel cells.”

Maintenance shows the clearest recovery from the effects of the Covid-19 crisis, MTU says



COMPONENTS

Singapore Component Solutions and Hutchinson team up

Singapore Component Solutions and Hutchinson have signed a Memorandum of Understanding (MoU) to work jointly on developing their component repair offering in the Asia Pacific region.

Under the terms of the partnership, Singapore Component Solutions – a joint venture between Sabena technics and Air France Industries KLM Engineering & Maintenance – will be appointed as the only approved repair station for Hutchinson in the region.

The partnership will begin in early 2021 and involve combining company skills “to offer the market a value-adding MRO service solution Hutchinson product”.

Capabilities will include engine and APU vibration isolation systems, engine component repairs, cabin interior and composite and structural repairs.

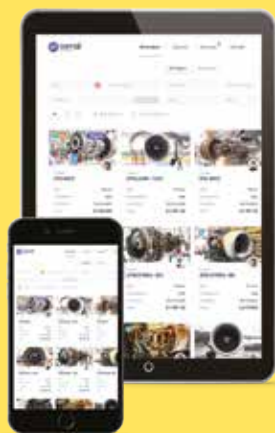
Singapore Component Solutions’ CEO Thibaut Campion said the partners would “develop jointly our repair network and capabilities in Asia”.

HANGAR TALK In brief

● Pratt & Whitney has added MTU Maintenance Zhuhai to its global network of providers that maintain the GTF engine. MTU Maintenance Zhuhai is a joint venture between MTU Aero Engines and China Southern Airline Company. It will provide engine maintenance for PW1100G-JM engines for the A320neo family.

● ● FACC has obtained EN 9110 certification as the Austrian company moves strategically into the MRO of aircraft components and systems. FACC said the certification is testament to the “high quality and expertise that FACC guarantees its customers in the maintenance, repair and overhaul of aircraft components and systems”.

● ● ● Bii.aero has boosted its stock of A320 family galley inserts having purchased a “significant amount” of inventory. This has been further supplemented by a large consignment from a major European airline which Bii will manage. The combined packages comprise more than 1,700 line items, the company said.



IT

Aeroji launches beta of engine aftermarket platform

Aeroji, a startup based in Berlin, Germany, is developing a social marketplace platform for aero engine trading and leasing. It says that it aims to digitise the aero engine procurement process including contracting and technical due diligence.

Having secured Kellstrom Aerospace, KG Aircraft Rotables, Onur Material Services, LCI.aero and Aeras Aviation as beta users, the team at Aeroji is looking to establish strong and long-lasting relationships with the first users in order to acquire further insights and improvement proposals and develop new features in a flexible, creative and collaborative way.

The beta stage is scheduled to last for four months. Beta users could begin exploring the platform with all its features in a playground phase in December.

Starting from January 2021, the three-month operational beta phase will begin with users interested in engine transactions and with real asset items in the database.

ENGINES

AAR partners with FTAI in CFM56 USM agreement

AAR and Fortress Transportation and Infrastructure Investors (FTAI) have signed an exclusive seven-year CFM56 used serviceable material (USM) partnership deal.

The partnership will provide CFM56 engine material to the global aviation aftermarket, as well as FTAI's own consumption at its dedicated commercial maintenance centre. AAR will manage the teardown, repair, marketing and sales of spare parts from FTAI's CFM56 engine pool, totalling more than 200 engines.

“AAR is very pleased to partner with FTAI, a leader in aircraft engine ownership, by leveraging our extensive USM capabilities to offer CFM56 serviceable engine material to the global commercial aviation aftermarket,” said AAR's president and chief executive officer John Holmes.

“This partnership positions us well to service the growing demand for USM on a leading engine platform as customers increasingly prioritise more cost-efficient solutions.”

FTAI's chairman and chief executive officer Joe Adams commented: “We are excited to offer an attractive USM

The partnership will provide CFM56 material to the global market

solution to the CFM56 aftermarket with our partner AAR, the independent market leader in aviation parts. We believe serviceable engine products, combined with our proprietary products and partnerships, completes our unique suite of CFM56 aftermarket offerings aimed at delivering the lowest cost per cycle solution to our airline customers.”



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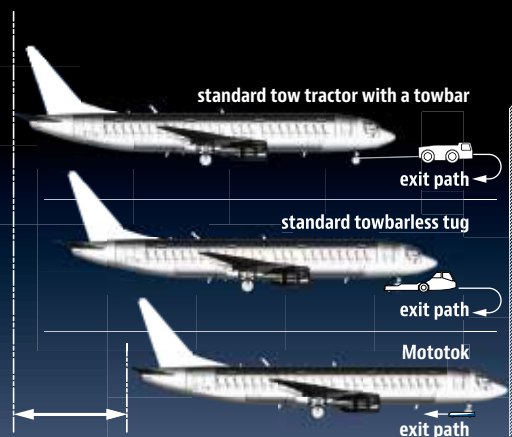
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MAINTENANCE

FL Technics completes acquisitions

FL Technics has announced the acquisition of Wright International, a provider of line maintenance services in Canada. It marks FL Technics' entry to the North American aviation services market.

Wright International provides aircraft line maintenance services up to 'A' level checks, A.O.G. support and training for airlines at Canada's major international airports, including Toronto Pearson, Vancouver, Calgary, Montreal Mirabel and Ottawa.

FL Technics has added to its line maintenance network in both Canada and the UK

In a related move, FL Technics subsidiary Storm Aviation has acquired SR Technics' UK-based line station network. The network provides fully supported aircraft turn-around services, including planned and casualty maintenance, transit, pre-departure and overnight defect rectification as well as other checks for many types of commercial aircraft.

Five line stations will be transferred to Storm Aviation ownership – at London Heathrow, London Gatwick, London Stansted, Manchester and Birmingham airports – as well as a tooling, loan, repair and calibration centre at Stansted.



COMPONENTS

IHI Group promises to support biofuel initiatives

The IHI Group has made a pledge to develop lighter aero engine components and support algae biofuel and electrification initiatives.

The Japanese company, which is involved in the manufacture and maintenance of various aero engines, said it was taking a "multifaceted approach" to reducing CO₂ emissions in aviation in its 2020 Integrated Report. IHI said it would also support operational optimisation through digital twins.

In terms of electrification, IHI said it was exploring autonomous air cooling systems, engine embedded electric machines and metering-integrated fuel-feeding electrification.

"The biggest challenge is development of a large-capacity electric motor generator that can handle the necessary increase in power consumption," the report noted. "IHI is developing an engine embedded electric machine

which achieved a rated output of 250 kW in ground tests in February 2020. In May 2020, we completed the world's first successful evaluation test of an air cooling system for 100 kW-class power electronics. We will optimise the system by linking it with electrification of the fuel system and the air conditioning and cabin pressurisation control system, which are currently under development."

The report also gave an update on IHI's efforts to develop technology for the stable production of bio-jet fuel from fast-growing microalgae, a project started in 2017. In addition, the company has been developing an integrated process for reforming oil extracted from the algae to manufacture fuel.

"We aim to quickly begin commercial production of bio-jet fuel," IHI said. "In FY2020, we plan to supply our fuel for use in the aircraft of domestic regular airline routes for commercial demonstration flights."

250KW

The number of watts an IHI engine embedded electric machine achieved in ground tests

Illustration: Phil Couzens

AVIATION

Business News



Exclusive features, industry interviews, expert opinion and all the latest news from the cabin, cargo, MRO and low-cost & regional airline industry

A year of challenge and change

AJW Group chief executive officer *Sajedah Rustom* explains how the company turned a potential Covid-19 crisis into an opportunity to evolve and re-focus for the future



As the aviation sector continues to fight against the pandemic's impact, few have been immune to the economic downturn. We, along with many others, have had to adapt accordingly; stabilising and optimising our business whilst continuing to play to our strengths.

As an independent business we were quick to act as the world entered lockdown. We proactively worked with our contracted customers to understand their short-term operational needs by adjusting minimum contracted hours. We created agile solutions to help mitigate the effects of the crisis all whilst guaranteeing the continuation of negotiated levels of support.

We evolved nearly all our services and designed new tailored solutions to serve our customers and meet their changing needs. We launched a successful streamlined lease solution with built-in repair costs which helps customers

reduce and limit their operating costs with no upfront lump sum or costly part depreciation.

We also worked closely with our MRO customers to ensure repair requirements were met on a 'just in time' basis and offered flexible cost-saving solutions to enable customers to conserve cashflow. For example, AJW Technique launched a 'Quote and Hold' programme, allowing us to hold components in-house after conducting a thorough evaluation and providing a detailed quote to let customers plan their financial exposure and smartly position their unserviceable components in the right place.

Outstanding teamwork, flexibility and the AJW 'can do' attitude ensured that we continuously delivered our expert-led customer service from home or from socially distanced working environments at our global facilities 24/7/365.

90

For AJW, we hope to look back over our 90 years of business and see this as a pivotal period where we took the opportunity to evolve and re-focus our business ready for the next 90 years



Despite the restrictions, we successfully renewed a seven-year complete supply chain solution contract with EasyJet, which included the creation of a new EU-hub in Malpensa, Italy. We also completed the purchase of three ex-Thomas Cook A330 aircraft and initiated teardown on-site at Manchester Airport to increase the levels of component availability.

We were quick off the blocks to accelerate our digital transformation plans. Covid-19 sparked an accelerated need for digital innovation within all industries to eliminate administrative work through automation and to elevate the workforce into more strategic functions for reduced cost and increased efficiencies.

We pushed digital solutions for increased productivity with an immense emphasis on better management of our

Clockwise from left: AJW adapted quickly to the crisis to ensure parts moved efficiently; CEO Sajedah Rustom led efforts to evolve the company in a “pivotal” period; an A330 teardown



supply chain and labour capacity in line with rapidly changing demands. We have dedicated a considerable amount of manpower and focus on building the right digital tools and dashboards to closely monitor the industry and fleet recoveries by customer and platform. This ensures that our customer service operations are in line with projected demand.

We also accelerated projects for activity trackers, purchase order dashboards, turnaround time alerts, automated notifications, credit control automation, piece parts provisioning, automated quoting and pricing models and launched an e-commerce platform. In it, our heavily discounted surplus Airbus and Boeing inventory can be viewed and purchased online at the click of a button.

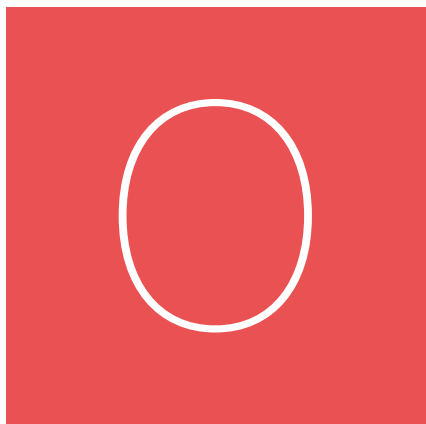
We also launched a new customer portal which offers immediate access and complete transparency for quotes, orders and tracking. All the digital developments will provide a further increase in the support and customer experience required for the future.

2020 will always be remembered as the year that saw the world forced to stop by the hand of a virus. But, for AJW, we hope to look back over our 90 years of business and see this as a pivotal period where we took the opportunity to evolve and re-focus our business ready for the next 90 years. **M**

We were quick off the blocks to accelerate our digital transformation

Legal matters: safety compliance

For most MROs, safety management systems regulations are on the horizon. Washington Aviation Group president **Jason Dickstein** says work can be done now to ensure compliance and maximise value



One of the most significant changes to the MRO management world is on the horizon: it is safety management systems or SMS.

SMS is a tool for managing a company's compliance to safety standards. It has been used in the labour and employment realm and it has been a topic of discussion in aviation circles for decades.

The International Civil Aviation Organization (ICAO), which is part of the UN, recommended that SMS be required for all MROs. On the strength of this recommendation, SMS has been required by the repair station regulations of a number of nations.

However, there is a growing movement for authorities like the Federal Aviation Administration (FAA) and European Union Aviation Safety Agency (EASA) to follow this groundswell and apply SMS regulations to MROs.

The four pillars of SMS are:

- safety policy;
- safety promotion;
- safety assurance; and,
- safety risk management.

The safety policy pillar requires establishment of a safety infrastructure. Some of the elements, such as an accountable manager, are already well-entrenched in normal MRO operations. Some of the elements include formal internal recognition and endorsement of the SMS programme, and these ought to be simple to implement for many MROs.

Establishing safety goals under this pillar can be more tricky than it might seem at first, because one must balance reasonable goals that are achievable against useful goals that help drive the business in a positive safety direction.

Similarly, safety promotion should be familiar to most MROs because it involves training and communication to promote a positive safety culture within the MRO.

Many elements of safety assurance should be likewise familiar to MROs. The core of safety assurance involves auditing (or using other oversight

mechanisms) to ensure that risk controls are appropriately implemented and are achieving desired results. However, there is an integration between safety risk management and safety assurance that makes safety assurance more complicated – and also more useful – for the implementing MRO.

Effective implementation of safety risk management is the lynchpin to SMS. Everyone who has ever worked in quality assurance understands how to perform a root cause analysis and how to identify remedial actions in order to correct that root cause. SMS takes this to the next degree of formalisation, though, by using:

- proactive identification of hazards;
- comparative weights for identified hazards to assess their relative risk to the organisation's safety goals;
- tracking of the mechanisms for controlling the identified risks;
- assessment of success in controlling risks; and,
- formal connection of corrective actions to identified hazards in order to have a formal mechanism for assessing the safety impact of change. (I think this change management feature is one of the

**To extract value from an
SMS, devote attention to
development and customisation**

Clockwise from left: The FAA has identified the need for safety management systems as part of its 737 MAX corrective action; Washington Aviation Group president Jason Dickstein



least understood and also most important benefits of an SMS).

Effective safety risk management allows better visualisation and oversight of the safety compliance efforts of the business. It provides tools for benchmarking safety performance and a mechanism for ensuring that safety is maintained through changes.

It helps an MRO to identify safety priorities to better manage scarce safety resources within the business – intelligently targeting these resources to maximise their value. It also helps to build effective internal auditing programmes that can focus on the safety needs of the business, without wasting

auditing resources where they provide little or no value.

For most MROs, SMS regulations are on the horizon. Even before the regulations are enacted, though, SMS can be a useful tool for managing safety and compliance in an organisation. At Washington Aviation Group, we've worked with MROs to implement SMS and our experience shows the implementation process can be slow. It is not as simple as writing a manual and circulating it around the shop floor.

An MRO that wants to extract real management value from its SMS needs to devote attention to the proper development and customisation of the SMS programme, and to the corollary training and communications necessary to ensure that the programme is implemented properly among all employees.

With a number of MROs facing slower times while they wait for post-Covid-19 passenger traffic to return to 2019 levels, now could be the ideal time to implement a management tool like SMS in order to better manage the expected increase in MRO work that will be necessary when passenger transport once again increases. **M**



Calmer weather is on the horizon

NAVEO Consultancy managing director *Richard Brown* reflects on a turbulent year, but offers hope for a much brighter 2021



Aviation leaders tend to be optimists. Each dawn, they believe, promises a new start. The storm clouds will pass, they confidently say.

We are lucky that our industry is full of engineers, strategists and planners who are specifically trained to forecast and prepare for disruption and unscheduled events every day. Covid-19 though has tested the skills, patience and will of every positive thinker our industry has and made so very many of their best-laid plans obsolete.

During the global lockdowns in spring, we hoped air travel's recovery would be well underway by the end of 2020. Back then, forecasts were confidently expecting December's traffic to be down just 20 per cent on 2019's levels. As the year progressed, it grew clear Covid-19's impact on air travel, production and the MRO market would be far more profound

and prolonged than we had feared. The International Monetary Fund (IMF) has projected a 4.4 per cent global economic decline for 2020 – the worst since the Great Depression.

Air transport has cruelly reminded us all it is a cyclical industry. However, this is the first global pandemic that many of us have had to deal with, so how the MRO industry would be impacted was always going to be challenging to forecast.

Airlines, lessors, financiers, OEMs, MROs and parts suppliers continue to face unprecedented challenges, the

challenging, with the ability to respond quickly to fleet flex and changes to travel schedules being the name of the game.

In 2019, air transport MRO spend was US\$87 billion and was expected to be US\$91 billion in 2020. Now though, 2020 MRO is likely to be down 50 per cent overall, with the different types of MRO activity varying between -40 to -60 per cent depending on the levers that airlines can pull to reduce expenses. Discretionary items and high-spend items, such as modifications and engine shop visits, will be deferred if

The MRO market is unlikely to recover to 2019 levels until 2022 or even 2023

greatest of which is the high degree of uncertainty over recovery speed. After the 2008 financial crisis, it took six to seven quarters before aftermarket growth returned, but the impact was less severe than from Covid-19.

Back then, negative quarterly results in the range of -10 to -17 per cent were reported. Compared to the -50 per cent seen in the second quarter of 2020, those seem tame. The aviation industry has had to continually adapt to changing travel restrictions, lockdowns and resurgent virus outbreaks. Planning has been

possible. The MRO market is unlikely to recover to 2019 levels until 2022 or even 2023 – meaning three to four years of lost MRO revenue. The increased retirements of ageing, maintenance-intensive aircraft that would have required heavy airframe checks and third or fourth engine shop visits also reduce the material and labour hours required going forward – thereby reducing MRO expenditure for operators, but slashing revenue for OEMs and MROs.

One of the past decade's key after-market trends has been the availability and increasing acceptance of used



Many European countries are in a renewed lockdown; the fleet there is the least active of any region (only 50 per cent active in November). Even if the aircraft are active, they are often flying reduced hours/cycles, and load factors are still lower.

Secondly, the key to unsticking the pandemic is the availability and rollout of a vaccine. If the virus is under control, governments will relax restrictions that have grounded travel. Pfizer, Moderna and Oxford's exciting news that their vaccines were found to be more than 90 per cent effective in preventing Covid-19 has caused airline and aerospace stocks to rally.

The vaccine now looks likely to be more effective and rolled out faster than many had predicted just a few months ago. Consequently, there's talk of a more 'normal' life after April. Enhanced passenger-testing regimes to reduce quarantine requirements will also help unstick business travel – a key source of airline profits. This provides leadership with much-needed visibility on the likely direction of travel so they can plan.

With the vaccine rollout set to begin, air travel barriers can begin to be dismantled, and the industry can finally rebuild itself. There's now a more exact path for recovery. We need to get through winter, but the green shoots of recovery are there – spring and summer 2021 look to be much healthier.

We have to continue to leverage expertise, best practices and lessons learned. It's vital your company takes advantage of the opportunities that can't come soon enough. 

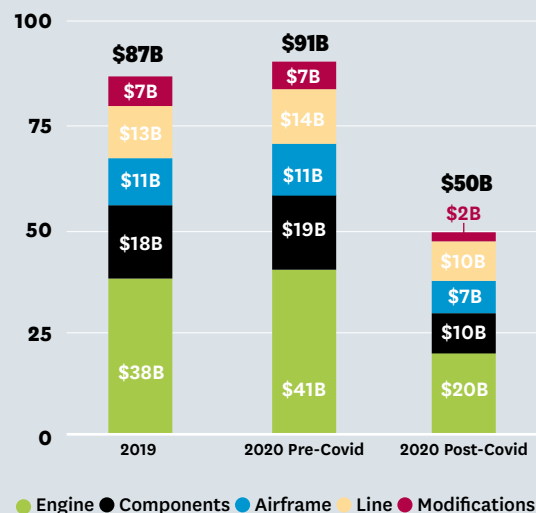
4.4%

The IMF has projected a 4.4 per cent global economic decline for 2020 – the worst since the Great Depression

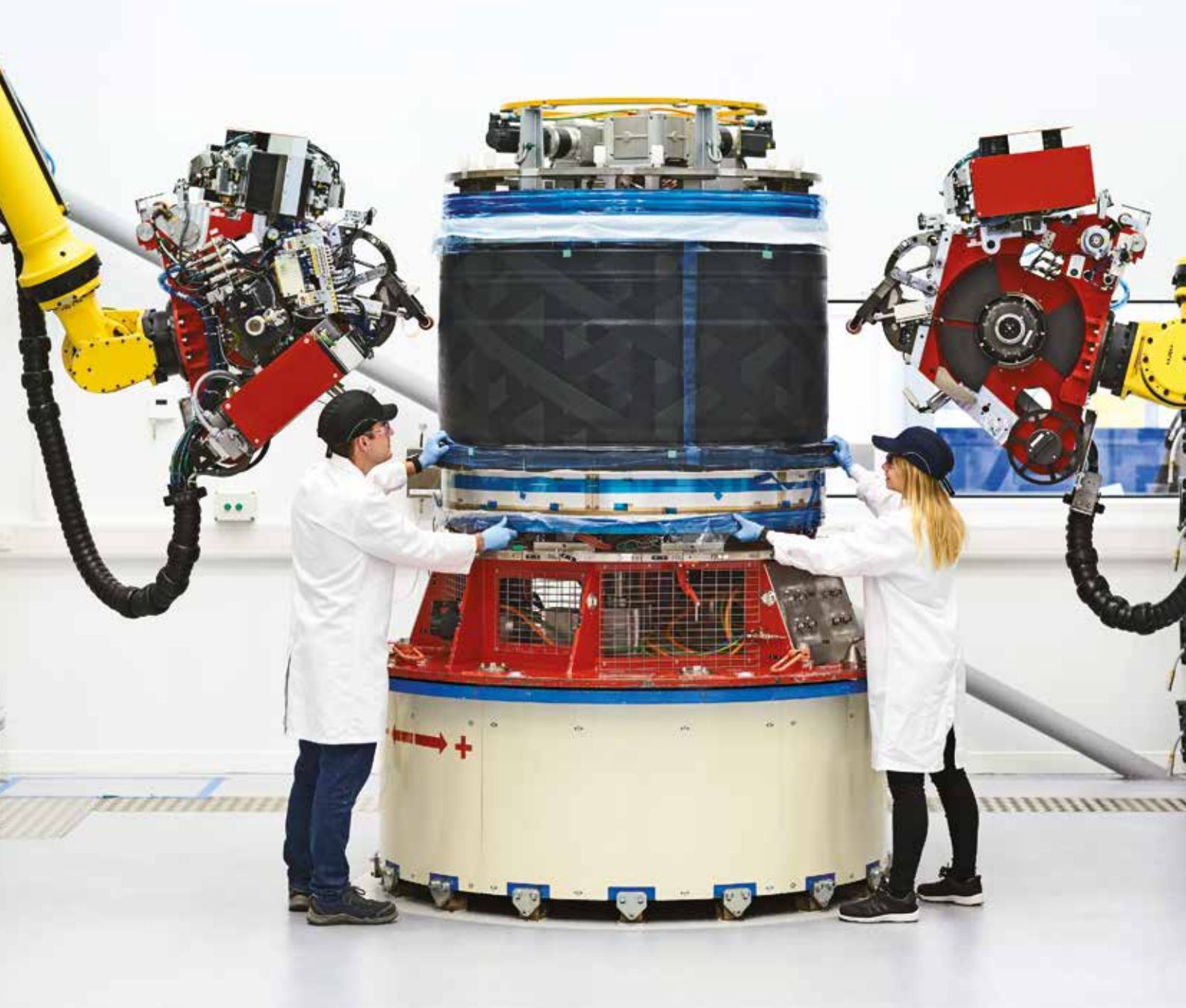
serviceable material and green-time engine management. Where possible, operators will consider using green-time engines in-lieu of an engine shop visit, surplus parts, part repair and, particularly in the cabin, PMA parts.

You'd be forgiven for thinking it's all doom and gloom. Look a bit closer, and several bright spots pave the way for 2021 seeing an MRO recovery. Firstly, the regional situation continues to diverge. Covid fatigue in the US has helped domestic travel recover, with 65 per cent of the fleet now active. The bright light continues to be China, where domestic travel has staged a remarkable recovery – 85 per cent of the fleet is in service.

Air transport MRO spend (\$B) forecasts



Source: NAVIO Consultancy



FUTURE FOCUS

Rolls-Royce is investigating 20 promising technologies as part of a new project to reduce waste, avoid emissions and minimise disruption

Rolls-Royce has launched an ambitious new project to accelerate future aerospace technologies. Engineers will work on 20 technologies that will aim to reduce disruption for airlines and lessen environmental impact by repairing components rather than scrapping them.

The project – called REINSTATE – has been launched with support from the ATI innovation programme, a joint government and industry investment to maintain and grow the UK's competitive position in civil aerospace design and manufacture. The collaborative team involved in the project is formed of some of the UK's leading industries and academic organisations.

“The REINSTATE programme aims to reduce our environmental impact, enhance our aftermarket services and develop technology for future engines to improve fuel consumption,” explains Dr Ian Mitchell, Rolls-Royce's chief of technology – repair and services.

Clockwise from left: Rolls-Royce's composite technology facility in Bristol, UK, will be key to REINSTATE; UltraFan offers a step-change in efficiency; snake robots enable complex repairs



Mitchell says the programme will improve maintenance techniques and deliver “substantial” CO₂ reductions by:

- utilising data to increase the time engines are available, avoiding unnecessary maintenance;
- reducing scrappage, repairing more components using new repair techniques rather than replacing them; and
- reducing the movement of people and parts around the world by using more digital inspection techniques, allowing engineers to inspect engines remotely.

The 20 technologies are designed to address some of the main aspects of engine maintenance and are grouped into five themes. “We chose projects that have a balance of supporting our future engines, considering the challenges brought by propulsion systems of the future, but looked to balance that with technologies we believe could be implemented in the shorter term [in the next 3-5 years] to support our current fleet and customers,” says Mitchell.

The five themes are:

- on-engine diagnostics and tools for monitoring engine health in operation;
- repair and maintenance of the engine when on the ground without the need to induct into an MRO shop;
- data collection and inspection technologies aimed at improving understanding and capturing of component condition once the components are exposed at an overhaul;
- repairing the components once the engine is stripped in an MRO shop; and,

- looking to the future and considering the challenges brought by next-gen gas turbine engines such as UltraFan as well as hybrid-electric systems.

The technologies vary widely in scale and scope, with the partners involved having expertise in a range of fields, from robotics to photonics, and from additive manufacturing to machine vision. The technologies include:

- snake robots – these travel inside jet engines to access complex parts, enabling repairs which are not possible with today’s tools;
- engine sensors – data is sent which improves predictions of when engines need maintenance;
- inspection and analysis tools – these inspect parts buried deep within engines while they are being repaired; and,
- advanced automated repair technologies – parts which cannot

“We will enhance our aftermarket service offering, introducing new technologies”

currently be repaired are targeted, meaning they do not need to be scrapped.

Miniature maintenance and inspection tools, as well as new repair technologies, will be used on Rolls-Royce’s existing engines such as the Trent XWB.

Another core aspect of the REINSTATE programme is an exploration into how to repair and maintain aerospace materials and components for future low-carbon engines, including electric technology. “Net zero is at the heart of our future growth strategy. As part of that, we’re working on a range of new technologies to decarbonise aviation,” says Mitchell.

“These include pursuing step changes in engine efficiency through our UltraFan engine design, as well as working on several disruptive electrical aviation technologies. Our future engine designs, whether gas turbine or hybrid-electric, will use advanced components which reduce weight and emissions. It’s vital that we have the inspection and repair technologies in place to service these new products when they enter service.”

While Rolls-Royce is working on a range of disruptive technologies such as electrification and hydrogen, gas turbines remain the immediate future for large engine propulsion. “We are delivering a once-in-a-generation change in our engine design with the UltraFan demonstrator, which will be 25 per cent more efficient than our first Trent engine,” reports Mitchell.

“Ground testing of the demonstrator will take place in 2021. UltraFan features composite fan blades and casing, which reduces weight. The technology is being developed at a composite technology facility in Bristol, UK. Engineers working on the REINSTATE project will work closely with our teams in Bristol to explore inspection and repair technology for composite fan systems.”

The impact of these technologies will be strongly felt in the MRO industry. “The technologies will enhance our aftermarket service offering, offering benefits to operators of Rolls-Royce engines and introducing new technologies into our MRO network,” Mitchell says. In addition, the benefits Rolls-Royce hopes to derive from the programme go far beyond the MRO industry, too.

“Some technologies will have multiple uses,” he explains. “For example, miniature chemical analysis tools can be used in nuclear power generation where human access is restricted. High-tech cameras and algorithms will help to identify damage on components in sectors as diverse as security and off-shore wind turbines.

“It is hoped that while the focus of this project is the civil aviation market, there will be opportunities for the innovation to transition into other sectors.” **M**

Changing with the times

Lufthansa Technik head of corporate communications, marketing and political affairs Jens Krueger discusses post-Covid-19 opportunities with **Melissa Moody** as airlines seek out digital platforms and shift MRO strategies



"It is clear this is a crisis of dimensions of which the aviation and aerospace industry has never experienced," he says. "It affects the whole industry and the longer it lasts, the more severe the consequences for all players will be."

Adaption is key

One of the biggest challenges for the MRO provider has been to keep the supply chain stable for customers. Despite the "massive" reduction of flight traffic, spare parts support services have to be carried out on a reliable base, Krueger explains.

"Fortunately, we have been able to overcome all restrictions caused by the coronavirus or by governmental protective measures and could support our customers effectively."

He says that there have been several factors which have had a negative impact on the business, one of the biggest being the "immense" reduction in global air travel, which has had a snowball effect on the rest of the industry.

"This has a tremendous impact on the economic strength of the airlines which

then have to reduce costs wherever they can," he says. "The more aircraft taken out of service by them, the lower the demand for MRO services will be. This situation will get even worse if more airlines have to completely stop their activities and go bankrupt, making consolidation in both the airline and MRO business inevitable."

Another major challenge for the business has been the adaption of its capacities. Lufthansa Technik has gone from working in a constantly growing MRO market to the opposite in a matter of months.

To keep things moving, the company has had to put a number of cost-saving measures in place including the reduction of investments, an immediate hiring freeze and the introduction of short-time working.

"Since the effects of the crisis will continue to be clearly felt in the aviation industry in the coming years, temporary measures will not be sufficient," Krueger notes. "But we have to adapt our structure, portfolio and numbers in our workforce to the actual market needs."

The company has also suspended asset purchasing, such as spare engines, and adapted capabilities within its international network, admitting that "at certain locations it has been necessary to let employees go".

Over a year since the first case of Covid-19 was detected, the aviation industry is still adapting to the upheaval the pandemic has brought. Lufthansa Technik is among the companies that has adapted to the crisis by altering the way it works aiming not just to survive but to prosper in the current market conditions.

Across the board, the company has seen a more than five per cent reduction in required man hours, although it varies "significantly" by product and region, according to Lufthansa Technik's head of corporate communications, marketing and political affairs Jens Krueger.

"There might be new opportunities for MRO companies as airlines review their strategies and outsource services they have kept in-house so far"



Clockwise from left: Lufthansa Technik has adapted its structure, portfolio and numbers in the wake of Covid-19; Jens Krueger is optimistic moving into 2021; the engine MRO market faces various uncertainties

The next step

One of the biggest ways MRO services have begun to adapt is with investment in digital services, an area which Krueger claims is seeing the strongest growth in its portfolio in the current environment.

"The increased use of digital solutions is one of the few possibilities to help airlines save money, therefore we have seen an increased interest in the market in this field and we expect that this trend will continue," he says.

He emphasises that investment in digital technologies and platforms such as Aviator are "paying off" despite the current climate. The cloud-based platform combines multiple apps in one place, accumulating and consolidating information at one central point and enabling exchange of information across interfaces. It applies analytical models to provide new insights, recommendations and notifications, "enabling customers to make faster and better decisions," according to Krueger.

Lufthansa Technik expects airlines to review their MRO procurement strategies and "embrace" digital solutions to help them reduce costs, increase reliability and gain more independence from OEMs.

But this digital shift is not the company's only focus. The 'classic' MRO business is still a priority for Lufthansa Technik, Krueger stresses.

"We are well positioned in the MRO service market for new aircraft generations, such as the A350, A320neo, 787 and – when back in service – the 737 MAX," he explains. "This includes their components

and engines, and we will further increase our efforts to create an attractive service product range in these areas.

"For example, we are expanding our international network for mobile engine services. There might also be new opportunities in the field of 'classic' MRO services as airlines review their strategies and might outsource services they have kept in-house so far."

This shift in airlines' MRO and procurement strategies should in turn create new opportunities for MRO providers. Airlines will look at their MRO partners to take over more of their engineering and maintenance functions in order to participate in industry-standard practices and modernise their engineering and maintenance functions, Krueger says.

Thinking ahead

Looking forward, Lufthansa Technik doesn't expect the air traffic and MRO market to return to pre-pandemic levels until 2023 or 2024, but is determined to find every opportunity it can.

"Generally, crises always bring about a rethink of strategies and this time will be no different for most airlines," says Krueger. Although the timing might vary a bit, the Covid-19 effect will be felt in the different MRO fields for "some time to come".

"Not every airline will survive this extreme situation; neither will every MRO company," says Krueger. "We believe that engine MRO is facing an intense cost pressure while the usage and availability of used serviceable material will increase.

"We forecast engine MRO to reach the level of 2019 in mid- or end-2024. Besides increasing green-time management, the engine market is facing various uncertainties, such as widebody engine recovery. The financial burden is massive in this period."

But Krueger remains optimistic about Lufthansa Technik's position in the MRO industry: "We have been number one in the market before the crisis," he concludes. "And we plan to keep this position in the current period, and in the future when the market recovers." 





M R O

S O F T W A R E

A D V A N C E M E N T S

Software used in the MRO industry is a vital aid to operations and the providers of such IT have continued to make product enhancements throughout the Covid-19 outbreak, as *Bernie Baldwin* reports



“When the pandemic first impacted our region of Canada in March, we enforced a remote work policy for all staff, which will remain in place until at least Spring 2021. Since we already had the necessary tools and infrastructure in place, the transition to a remote work environment was simple,” Vergeer adds. “We have also continued to facilitate online demonstrations of ‘WinAir Version 7’, the latest and fully browser-based edition of our software, to businesses worldwide that are interested.

“Our Aircraft Services and Software Implementation teams are also working on a virtual set-up. As a result, we are offering remote WinAir Version 7 software implementations for new clients, as well as remote upgrades for existing clients. We also recently released new software enhancements and updates, and have many more scheduled for 2021.”

IBS Software’s VP of corporate communications James Blamey outlines his company’s coping strategy: “As the situation unfolded, we made it our focus to be as flexible as possible with our customers, helping them adjust and manage delivery timelines. We worked closely with them to ensure open and regular communications, to remain relevant and trusted.

“With many of our customers responding to the business slowdown, we were able to use this opportunity to innovate and implement new digital processes and enhance core areas of the product to increase efficiencies and cost savings for the customer. In fact, it has almost been business as usual for our customers.”

Blamey notes that IBS Software has increased its focus on DevOps, cloud

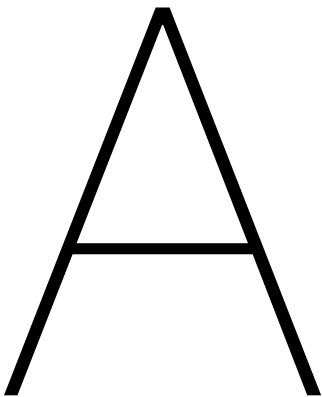
migration and agile adoption activities. He adds: “As a group, we were already clued into remote working, managing cross functional teams, practising remote stand-up meetings over Microsoft Teams and looking into ways to automate development tasks. In fact, in a recent company survey, we found an increase in overall productivity on software teams since the pandemic started.”

Chris Clements, sales representative for Swiss AviationSoftware (Swiss-AS), tells a similar story of pushing onwards. “From a development point of view, Covid-19 has had little or no impact on the road map due to the fact that ‘AMOS’ already had technology available to let our customers adjust to pandemic restrictions and conditions,” he confirms.

“Whether this is utilising the ‘Approval Control’ framework and workflows to automate selected transactions or to adopt fully paperless processes and ‘E-Signature’ including ‘AMOSmobile/EXEC’, AMOS has many features that support end users in performing tasks with all relevant data to hand. At the same time, remote maintenance and social distancing can be adhered to whilst ensuring quality, safety and compliance.”

Reflecting on internal practices, Clements notes: “Like many businesses,

it has been a challenge to manage the ‘new normal’, working to ensure that not only are our customers’ needs met, but also that we do not lose focus with the continued advancement of the AMOS platform.



Among the providers of software designed to streamline MRO operations, competition has been fierce for several years, with many different companies offering a wide variety of IT solutions. With start-ups, mergers, acquisitions and occasionally a closure, it is a very active sector of aviation – and this year it’s had the added difficulty of dealing with the Covid-19 pandemic.

Companies have therefore been learning to cope throughout lockdown periods. Kyle Vergeer, managing director of Canada-based WinAir, explains that while 2020 has presented many unforeseen challenges, his company has adapted accordingly. “That has allowed our team to continue to provide world-class service and support to clients which use our aviation management software,” he says.

“We found an increase in overall productivity on software teams since the pandemic started”



“Of course, the ability to meet new customers and provide services to the existing AMOS community in person has been curtailed. In some isolated instances, we have seen resistance to going online for services from some customers, but having then proven the effectiveness of the delivery and successful result, the projects have been able to continue despite the travel ban,” Clements confirms.

At Aircraft Maintenance Systems (AMS), work has been adapted to keep in contact with clients whenever they needed it. “Our priorities were to keep the satisfaction of our clients and be sure that they still had the information and answers they needed every day,” says VP marketing and business development Arnold Aumasson. “AMS has 300 clients in 40 countries and teams across geographies, so we are organised to work remotely and be agile, particularly as 2020 also saw the launch of our new solution, ‘AIR22’. We made strong

investments in the last three years and were committed to delivering on time. Thankfully, the impacts on our roadmap have been very limited.”

Aumasson’s mention of AMS’ new product underlines providers’ continued push for greater functionality. Thus, while maintenance software is already quite sophisticated, companies are still finding ways to speed up processes and make them more efficient.

“A lot can be done on the user experience to save time and limit errors. Bringing simplicity and mobility is key in today’s world; younger generations are now using our products and we have to

While software is already sophisticated, companies still find ways to speed up processes

Clockwise from main image: Swiss-AS continues to advance AMOS; WinAir’s improvements focus on reliability and lean inventories



adapt to new ways of working,” the AMS VP posits. “We have reported a doubling of the efficiency on certain tasks with new features in our new solution when compared with the previous versions.

“Ultimately, improvements can also address the overall cost of a solution. Web-based technologies helped us to offer flexible prices that fit every client’s needs and sizes, from small MROs to large airlines. With a subscription-based model, you can manage an aircraft for €10 per month,” he declares.

Improvements at WinAir have been about expanding reliability to improve processes for businesses to make them more efficient, according to Vergeer. “By building upon our reliability programme, we can provide our clients with more analytical information to make better and more sound data-driven decisions, leading to better maintenance planning and more accurate forecasting. All this will provide these aviation operators and MROs with a more economical approach to managing their businesses by maintaining lean, yet fully prepared, inventories while also continuing to assist them with ensuring the airworthiness of their aircraft.”

For Swiss-AS, it is the level of adoption of all of the benefits from software such as AMOS that ensures the most efficient and complete processes possible. “To exploit advantages such as paperless processes takes not only a large scale project to adapt the company processes, but perhaps most crucially, the approval from the local authorities,” Clements argues.

“For a C-check work package, it can be extremely challenging for an MRO provider to maintain a consistent level of efficiency when receiving a paper-based work package versus a digital file containing simply a list of MPD tasks versus a set of digital job cards via import,”

AMOS.



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Clockwise from left: AMOSmobile/STORES functions both on- and off-line; WinAir's desktop software lets clients make data-driven decisions

“New applications and implementations have to be up and running as quickly as possible”

he notes. “Swiss-AS continues to develop ‘AMOScentral’, and this will be something of a game changer in enabling an even greater level of freedom to the AMOS community to share and trade their data. Benefits will be realised in a seamless exchange of work package data, not only when delivered at the start of the check, but via regular updates throughout the execution until the conclusion.”

Developments at IBS Software have also continued under conditions created by Covid-19. “We have been improving our solution’s flexibility and ease of use by working on some degree of process re-engineering and definitions,” Blamey comments. “Location and unbound device access, mobile apps and agile business processes are becoming essential. Digitisation and digital transformation are key to reducing turnaround times for internal and external processes.

“Responsiveness is critical, now more than ever. New applications and implementations have to be up and running as quickly as possible. They also have to be built for purpose with modularity so that businesses can start operating immediately, along with the ability to scale up as they grow,” he adds.

As for the key new function added recently by IBS, Blamey reports: “We have introduced the ‘iFlight MRO Mobility’ app that includes a dedicated line maintenance module, used by line mechanics and inspectors in daily activities such as recording log pages, raising a defect, requesting parts, performing removals and installations and carrying out electronic sign-offs and deferrals.

“The app is supported across iOS, Android and Windows phone platforms. Once installed, mechanics and inspectors get instant access to assigned or available work orders and the electronic task cards they can refer to in order to carry out the assigned activities.

“They can then have them signed off electronically in the app and in accordance with full regulatory compliance. The process supports the growing trend of virtual inspections by the regulatory authorities, accelerated by the pandemic, since on-site visits cannot be carried out.”

A new qualification and training enhancement for WinAir Version 7 is the latest addition to its platform, Vergeer reports. “This will revolutionise how businesses manage staff credentials relative to aircraft maintenance.

“Typically, aviation operators and MROs manage staff authorisations, qualifications and personnel requirements as mutually exclusive activities that are not tracked relative to actual aircraft maintenance tasks. This is problematic as completing maintenance tasks depends on staff having the right credentials. With our

‘Qualification and Training’ enhancement, businesses can save time and ensure compliance by tracking staff credentials and aircraft maintenance together.”

As mentioned by Aumasson, AMS’s key development this year was the launch of its AIR22 solution. “On top of all the business must-haves, we added innovative features such as ‘Timeline’ and ‘Global Consultation’, highly expected by our CAMO and operator clients. These help our clients understand their business better and enhance their operations,” he says.

“We strongly oriented our platform to position our clients at the centre of their ecosystem for their daily operations. Using easy-to-implement connectors, we facilitate exchanges with the community.”

With Swiss-AS having brought several new functions to AMOS recently – such as AMOScentral and the ‘Line Maintenance Manager’ – Clements does not find it easy to select just one key development. “AMOSmobile/STORES, itself a mobile stores device, may not be the biggest key change; the tech platform that it sits on – ‘Google Flutter’ – is perhaps the more exciting evolution,” he remarks.

“This has enabled us to produce native apps with the capability to function both on- and off-line in a hybrid manner. Having adopted this for AMOSmobile/STORES, AMOSmobile/EXEC2.0 will follow in the near future as well as additional targeted future AMOSmobile applications,” Clements states.

While airlines and their MRO providers may have been suffering this year, they can rest assured that their maintenance software providers have managed to keep on top of their operations – and even added functions which will increase efficiency and deliver cost savings. **M**





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Clockwise from top left: Boeing projects in Brazil and the UAE (first three images, source: Boeing); a passenger flight from Abu Dhabi to Amsterdam in January 2019 used the first batch of fuel from the UAE project (source: Etihad Airways); an Emirates A380 delivery flight was powered in part by a biofuel blend (source: Emirates)



Fuelling the FUTURE

The rapid and worldwide scaling up of sustainable aviation fuel would help enormously in demonstrating environmental leadership and reaching climate targets.

But is it achievable? *Jason Holland* reports

W

When Emirates welcomed its 116th A380 in early December 2020, the delivery flight was powered by a blend of conventional jet fuel and biofuel produced from used cooking oil in Finland. It marked the first time the airline had used sustainable aviation fuel – a broader term describing synthetic kerosene that is preferred by the industry to aviation biofuels – to power an A380.

“We are watching developments in sustainable aviation fuel very closely, and we look forward to a time when it can be produced at scale, and in a cost competitive manner,” said Emirates Airline’s president Sir Tim Clark after the delivery flight. “This is a positive step towards reducing our overall emissions.”

Many delivery flights using sustainable aviation fuel have now taken place, along with other test flights trialling different types of biofuel over the years. And just a few days before the Emirates flight, Lufthansa Cargo and DB Schenker collaborated to operate a 777F cargo flight completely powered by sustainable aviation fuel. Regular CO₂-neutral flights will begin in spring 2021, the partners said.

So what does this all mean for the future of sustainable aviation fuel?

No single solution

The aviation industry is committed to decarbonising aviation and addressing the climate change challenge, and the move towards sustainable aviation fuel has implications for the MRO industry and the maintenance of aircraft, engines and components. But despite many years of progress, there is still a long way to go for sustainable fuel – several hurdles have become apparent, of which many have yet to be fully resolved.

The production of some biofuel has raised concerns such as potential changes in the use of agricultural land, water use and the effect on food prices; as well as the impact of irrigation, pesticides and fertilisers on local environments, according to the Air Transport Action Group (ATAG), an industry body set up to promote aviation’s sustainable growth for the benefit of global society.

“To avoid these negative impacts, the aviation industry has been careful to promote only sustainably sourced alternative fuels,” the association states. “This is why the industry uses the term ‘sustainable aviation fuel’ which has

also sometimes been referred to as ‘next generation’ or ‘advanced’ biofuels.

“Sustainable aviation fuel provides [the industry] with the capability to partially, and perhaps one day fully, replace carbon-intensive petroleum fuels. They will, over time, enable the industry to reduce its carbon footprint significantly.”

The world’s two leading commercial aircraft manufacturers, Boeing and Airbus, are at the heart of sustainable fuel programmes and development. Boeing Commercial Airplanes’ director of environmental strategy Sean Newsum explains that it’s “a global issue that requires global co-operation – with no single solution”.

On his company’s input, Newsum says: “We’re actively involved in carrying out aviation’s ‘all of the above’ strategy to reduce CO₂ emissions by advancing future airplane technology, improving network operational efficiency and transitioning to renewable fuels.

“Sustainable aviation fuels are proven, used daily, and widely seen as offering the most immediate and largest potential to decarbonise aviation over the next 20 to 30 years. Boeing has been a leader in

fostering their development since before the first test flight in 2008. We worked with airlines, engine manufacturers and others to conduct further testing and gain certification for commercial use in 2011.”

Some sustainable fuels perform better than conventional jet fuel

80%

Sustainable aviation fuel can reduce CO₂ emissions by up to 80 per cent during its full lifecycle

40

More than 40 airlines now have experience with sustainable aviation fuel

250k

Over 250,000 flights have taken to the skies using sustainable aviation fuel since 2016

Source: IATA



Boeing continues to collaborate with partners around the world to create regional supplies. Newsum says: “We’ve worked with partners to produce sustainable fuel from purpose-grown sugarcane in Brazil, nicotine-free tobacco plants in South Africa and plants in the United Arab Emirates irrigated with seawater, among other efforts.

“The UAE project is a good example of solving two problems at once. Oil from the plants is used to create sustainable fuel, while farm-raised fish that fertilise the plants help feed a nation that imports nearly 85 per cent of its needs. Etihad Airways, another partner in the project, flew from Abu Dhabi to Amsterdam in January 2019 using the first batch of fuel from this endeavour.”

When produced sustainably, scientific studies show that sustainable aviation fuel reduces CO₂ emissions by up to

80 per cent compared to petroleum fuel over its life cycle, Newsum notes. Some sustainable aviation fuels even perform better than conventional jet fuel. “Their higher energy density means less fuel is required for the flight and they reduce particulate emissions,” he says.

Bringing down barriers

The main challenges now are scale, technology and cost. For Newsum, the most immediate barrier to wider production and use of sustainable aviation fuel is the broader availability of government incentives “to close the cost gap for our airline customers”.

He explains: “Government incentives to producers and users are critical to accelerate development of commercial-scale supplies at competitive prices. New sustainable fuel pathways continue to be developed that can create fuels from a

larger variety of feedstocks and different processing technologies. Costs should come down as production scales up and additional technologies mature in concert with government support, which should drive additional market growth.”

According to Newsum, 14 sustainable fuel production plants and refineries around the world are in operation, under construction or in advanced planning stages. These facilities have a potential annual capacity of 3.5 billion litres by 2025.

It is also important to note that sustainable fuel can be made from a wide variety of sources: non-edible plants, agricultural and forestry waste, non-recyclable municipal waste, industrial plant off-gassing, and other feedstocks.

Chicago area-based LanzaTech has produced sustainable aviation fuel by capturing carbon at industrial plants, Newsum notes. Fulcrum Bioenergy is

Left: Boeing, Etihad Airways, Khalifa University and several others were founding members of the Sustainable Bioenergy Research Consortium near Abu Dhabi. Plants at the desert ecosystem are irrigated with seawater (source: Boeing)



working on producing fuel from municipal waste, with plants in Nevada, USA, and the UK. “Future production pathways could include electrofuels and other bio-based sources of sustainable fuel that sequester carbon during their growth cycle,” he adds.

About 80 per cent of aviation emissions come from flights longer than 1,500km. Newsum thinks sustainable fuels are key to long-term, large-scale emissions reductions from larger aircraft on these routes, while other renewable energy solutions will be developed for shorter-range markets and future aircraft.

**“It’s a global issue
that requires global
co-operation – there’s
no single solution”**

Commercial prospects

Some 40 million litres of sustainable aviation fuel will have been produced in 2020, according to the International Air Transport Association (IATA), representing just 0.015 per cent of total jet fuel. Seven technical pathways exist to generate sustainable aviation fuel, the association says, with a further eight in the pipeline for testing and approval over the coming years. Each pathway widens the opportunities for more sustainable aviation fuel to be supplied over time.

ATAG offers a clear route to

commercial viability. “Since the first test flight in 2008, the technological progress has been remarkable. However, the actual uptake of sustainable aviation fuel is modest relative to total industry demand. This is

in part due to these fuels still being produced in relatively small quantities,” the association says.

“Without economies of scale, the unit cost of production remains, in general, higher than traditional fuel and this price impediment is limiting its wider use. For sustainable aviation fuels to be scaled up to commercially viable levels, substantial capital is required to develop the refining and process capacity.

“Moving a technology from the research to the commercial phase can be extremely challenging and requires substantial investment. Building a small-scale demonstration facility requires a fraction of the capital required to develop a commercial scale facility. However, even if a demonstration scale facility performs as expected, moving from small scale to commercial scale can still be risky.

“Addressing this funding gap should be a priority for policy makers who have the available tools and mechanisms to bridge the gap and enable progress in this new industry. However, once the cost of production facilities has been de-risked, it is likely that the cost of the new fuel will drop considerably, as has been seen in other renewable energy markets.”

In its Waypoint 2050 report, which brings together experts from across the aviation sector to “see how the industry can accelerate working together to contribute to the world’s climate action mission”, ATAG says: “It is likely that aviation will need around 450-500 million tonnes of sustainable aviation fuel per annum by 2050. Analysis shows that this is achievable, with rigorous sustainability criteria ensuring a transition that does not impact food or water use. Rather than relying on a single option, there are a range of feedstocks available, from non-food crops to waste sources and eventually a shift to power-to-liquid fuels made from recycled or directly captured CO₂ and low-carbon electricity.

“The scale-up will be a significant challenge, although with the right support from government and the energy sector, it is far from insurmountable. Policy will play a core role in this shift – government support to channel feedstocks towards aviation and not other transport sectors, where alternative energy sources are already available.” 

A

At present, 40 per cent of the world's fleet of commercial aircraft is parked or stored. Hundreds of aircraft which until very recently were the flagships of the fleets of some of the world's most reputable airlines are now sitting forlornly at storage or disassembly airfields, never to fly again.

NAVEO Consultancy managing director Richard Brown says that during the initial Covid-19 global lockdown fully 80 per cent of the world's commercial-aircraft fleet was grounded. That includes approximately 800 Boeing 737 max jets which were grounded for safety reasons, but which have now been cleared to begin flying commercial services again.

Brown is careful to distinguish the difference between parking an aircraft and storing it. Parking means grounding an aircraft temporarily and not in a preserved state, so that its operator can bring the aircraft back into service with just a few days' notice.

Many carriers, such as EasyJet, often park aircraft they plan to bring back into service as soon as possible at airfields on or near their route networks. Operators ensure that those aircraft are physically

moved back and forth on the ground every few days so that the tires on their landing gears don't become misshapen, and will often fly the aircraft once every month or so.

Storing an aircraft usually means it is grounded for a much longer term – often years – and in some cases, perhaps many, a stored aircraft will never fly again. Aircraft operators and owners usually store their aircraft at airfields located in hot, dry climates to prevent corrosion by rainwater. These aircraft are also moved regularly to prevent misshapen tires, but the storage process usually involves covering the aircraft's engine inlets, windshields and windows to prevent them becoming damaged. Its tanks are drained of fuel to minimise the risk of fire.

Reactivating such aircraft takes weeks, if not months, because after being in storage for years an aircraft needs a major maintenance check and may also need to be repainted. Accordingly, airfields which specialise in storing aircraft – such as the famous 'boneyards' in southwestern USA – often have MRO and painting hangars, Brown notes.

When deciding to ground aircraft, owners and operators also have a third option: have an aircraft disassembled to reclaim reusable airframe and engine components and parts. The remaining parts of the airframe and engines can be broken down and processed for the value of the alloys, precious metals and scrap metal they contain.

While this can be very worthwhile financially to the aircraft's final owner



PARK, STORE OR RECYCLE?

With Covid-19 grounding thousands of commercial aircraft, *Chris Kjeldaard* reviews the state of the parked/stored aircraft market and examines how the aircraft recycling process works



Above: Mastermelt Aero is able to recycle materials in the engine to recover the superalloys, other exotic alloys and precious metals

(often a parts trader), the owner has to pay a disassembly specialist to part out the aircraft. They often also pay a reclamation specialist.

Difficult decision

Operating in a climate of uncertainty as to when passenger traffic might return to 2019 levels – just before the Covid-19 pandemic began biting – airlines and other aircraft owners must make the best decisions possible as to whether their aircraft are likely ever to re-enter service.

Brown says that in today's Covid-19-affected economic climate, oil and jet fuel prices remain low so many owners have little incentive to take delivery of the enormous numbers of new, more fuel-efficient aircraft they had ordered by 2019.

Consequently, they are choosing to defer deliveries and plan to keep in service many of the current-generation aircraft now in their fleets – particularly those which are younger and will need little or no major maintenance in the near future.

The same cannot necessarily be said for owners' older aircraft, Brown notes, particularly those which have reached 16 or more years in age and thus are well into their heavy-check MRO cycles. "Probably about 2,000 of those at-risk aircraft will never fly again," he says.

Many carriers have adopted a wait-and-see approach before they decide to retire aircraft, and have put their



Clockwise from left: ASI today disassembles as many as six aircraft at a time; Mastermelt performs engine tear-down and recycling work at a facility in Texas; parts are ultimately rendered useless

grounded aircraft into long-term storage because it represents by far the cheapest interim solution. Monthly storage costs a few hundred dollars rather than the thousands of dollars for major-airport parking fees. Ageing passenger types such as the 747-400 and 777-200ER are unlikely to be brought back, though.

Even many examples of the highly produced A330ceo family are at risk, because large numbers of A330s have been grounded in the pandemic and some of the older aircraft are seen as being unsuitable for freighter conversion.

In July, NAVEO forecast that about 6,400 aircraft would be retired from passenger service in the 2020-2026 period. While it reckons more than a third of them will be older A320ceo-family, 737NG-family and 757-family aircraft, thousands more will be older widebodies such as 767s, 747s and 777-200s/-200ERs/-300s/-300ERs, the bulk of the retiring 777s being 777-200ERs. This presents a dilemma to aircraft owners and to the aircraft recycling industry.

Uncertain times

Brown estimates that the aircraft recycling industry globally currently has capacity for disassembling about 600 aircraft annually. As more and more aircraft are parked, the market for used

serviceable material (USM) is becoming saturated by the over-supply of aircraft available for parting out, according to UK-based disassembly company Air Salvage International's (ASI) global sales manager James Cobbold. At the same time, there is less demand for that USM because operators are operating fewer aircraft and those aircraft which remain flying are doing so less frequently.

"There might be 800 aircraft getting parked up [in the next year] but only about 300 are being parted out, because nobody's buying them [for the USM they can provide]," says Cobbold.

Storage facilities will have lots of business, and freighter operators (and freighter conversion companies) will have plenty of suitable passenger aircraft available which will offer compelling operating economics as converted freighters. Cobbold says owners have selected so many aircraft for disassembly that ASI, which today is disassembling as many as six aircraft at a time, is now experiencing two to three months of lead time between signing a disassembly contract and beginning the work.

Before the Covid-19 pandemic, about 90 per cent of aircraft arriving at ASI's facility at Cotswold Airport in Gloucestershire (formerly RAF Kemble) had previously been contracted for disassembly. "Now a lot more are arriving with no [USM parts] buyer attached," he says. As a result, owners are increasingly asking ASI to store their aircraft for them which, because it has FAR Part 145 certification to do so, is bringing ASI useful additional revenue.

The disassembly process

Nowadays, disassembly of a commercial aircraft – one not primarily made of carbon-fibre composite material, at

any rate – is a very efficient process. Cobbold estimates that ASI always expects to recycle at least 92 per cent of any metal-based aircraft.

The only parts of an aircraft which generally aren't recycled are its interior wall,



Many carriers have adopted a wait-and-see approach before they retire aircraft



systems such as air conditioning, landing gear, the auxiliary power unit and the avionics. Avionics components are removed whole – being removed inside a hangar or in dry weather conditions – and sent to a repair shop, where they are re-certified for use on another aircraft or, if beyond economic repair (BER), stripped for parts. Unusable avionics parts are recycled. Passenger seats and fittings such as galley units are removed whole to be re-used or recycled for their materials.

Customers may also require removal of flight control surfaces (such as flaps, ailerons, elevators, rudder and spoilers) whole for re-use as spare parts. Any carbon-fibre composite parts or structures are separated out and cut into sections, which are sent to the aircraft's manufacturer (or other customer) for research purposes. In the future ASI expects to be sending carbon-fibre composite structures to dedicated recycling centres, but recycling of carbon-fibre composites is in its infancy.

Aircraft manufacturers and others (such as Aircraft Fleet Recycling Association member Adherent Technologies, which has a wet-chemical technology to recover carbon fibre from the matrix resin substrate in which it is embedded) continue to research how best to recycle large carbon-fibre structures in aircraft.

Professor R. Eric Jones, chair of the Aircraft Maintenance Science department at Embry-Riddle Aeronautics University, notes that aircraft manufacturers are increasingly using carbon-fibre composite in aircraft and are using it for larger and larger load-bearing structures, so they must believe that such structures are capable of being recycled successfully.

The disassembled aircraft's fuselage, including all the wiring it contains, is then crushed and sent to a melt shop for metal reclamation. However, in some cases the customer asks ASI to cut and preserve cockpit sections and large fuselage-skin sections for R&D work or smaller sections for other purposes.

92%

Cobbold estimates that ASI always expects to recycle at least 92 per cent of any metal-based aircraft

floor and ceiling fittings and overhead bins, because these are made of mixed plastics and can't be recycled for material recovery. These parts will probably end up in landfill. However, if a buyer is interested in acquiring the entire fuselage complete with plastic interior fittings after all disassembly of other components and parts is completed, between 96-99 per cent of the aircraft is effectively recycled, says Cobbold.

ASI first removes all high-value components and parts from an aircraft – about 800 to 1,500 in all, according to Cobbold. These include the engines (sold whole for parting-out or re-use by the owner, often an engine trader), hydraulics, pneumatics, electrical

AIRCRAFT RECYCLING

Right: Mastermelt has torn down some 3,000 turbine engines for customers all over the world

Engine final disassembly

All turbine engines, either completely whole or with re-usable parts removed, eventually end up in a BER state suitable only for scrapping. At that point an engine's owner can call upon the services of a specialist, such as Mastermelt Aero, to recycle the remaining materials in the engine to recover the superalloys, other exotic alloys and precious metals. After that comes one more highly important step.

Matthew Davis, global sales development executive for Mastermelt Group companies Mastermelt Aero and Mastermelt Alloy, says his company first sorts and segregates the superalloys in an engine. Long ago Mastermelt developed proprietary processes for removing all contamination from the surface of each blade in the engine. This includes removing the yttrium-zirconium-based thermal barrier coatings which prevent high-pressure turbine first-stage blades from melting in the intense heat of the exhaust gas exiting the engine's combustor.

Once all surface contamination is removed from blades, Mastermelt is able to retrieve all the platinum they contain, as well as all other precious metals contained in engine parts such as stators, fuel nozzles and manifolds. It then refines those precious metals – platinum, palladium, gold and silver.

Mastermelt sends decontaminated blades and other parts – minus their



Manufacturers continue to research how best to recycle large carbon-fibre structures

precious-metal content – to melt shops, which re-cast the superalloys and exotic alloys. The melt which produces the new alloy cast combines 75 per cent virgin (new) alloy material, with 25 per cent revert (old) material from the blades.

Aerospace superalloys and exotic alloys include in their chemical make-up one or more of nine elements which occur rarely in nature, such as nickel and cobalt. The 75/25 melt combination is environmentally significant considering that 50-60 per cent of the world's entire resource of cobalt – an element in high demand for various manufacturing uses –

is located in the Democratic Republic of Congo, a difficult place in which to conduct mining operations.

Mastermelt guarantees its customers that no BER engine part can possibly ever be used again in any engine

by performing two important actions, according to Davis. First it provides the owner with a documented secure chain of custody of the engine and all its parts. It then renders completely unusable all parts from which it has reclaimed the precious metals by mutilating them visibly and substantially.

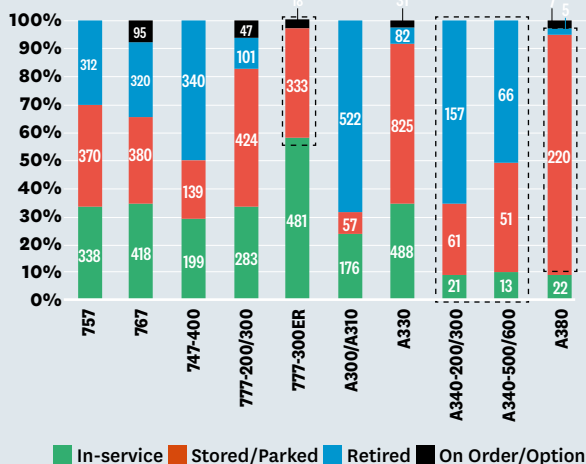
It films this work from start to end with closed-circuit TV cameras which time-code every video frame as it is recorded. It then gives the customer the resulting videos, accompanied with paper documentation certifying that it has successfully destroyed each BER part.

Mastermelt also provides the customer with a complete itemisation of what the BER engine contained in terms of the market value of its reduced-and-recycled superalloys, exotic alloys and refined precious materials. This is likely to form the basis of the negotiated final price for Mastermelt's tear-down of the engine and recycling of its constituent materials.

The company performs the engine tear-down and recycling work in a 50,000sq ft facility on the site of its eight-acre precious metals-refining facility in Texas. Mastermelt has handled final disassembly of a wide variety of volume-produced civil and military turbine engine types for aviation, marine and industrial use. To date, Davis says it has torn down some 3,000 turbine engines for customers all over the world, recycling 14 million lbs of engine materials in the process. 

FLEET & RETIREMENTS

Fleet status: in-service, parked, retired, on-order as % of total fleet



Analysing the % of an aircraft type that is active versus parked versus retired (as a total of all aircraft built) can yield insights such as:

- Likelihood of aircraft coming back into service from stored
- Demand for future USM and the likelihood of a retired aircraft being parted out straight-away versus parked for years

Some aircraft have fared better in terms of remaining in service perhaps due to two versus four engines, capacity and the availability of dedicated freighters or cargo conversion programmes

Source: Aviation Week Fleet Discovery June 2020, NAVEO Analysis



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Material **GAINS**

Clockwise from left: Zotefoams' materials can be used in a wide range of aerospace applications; director of HPP business units James Bridges; clean interiors and customer experience are key topics

Q & A



Zotefoams director of HPP business units **James Bridges** discusses the impact of Covid-19 on materials demand and design, and assesses what the future might hold for the aircraft foams market

The Covid-19 pandemic has thrust cabin health and hygiene into the spotlight. How do you expect this to impact patterns of demand for Zotefoams products?

Keeping passengers safe – and making sure they feel safe – is critical to airlines encouraging people to fly again. Zotefoams materials are bio-inert and have a closed cell structure which does not promote viral or bacterial growth, so all the signs are that demand will increase as cabin designers explore new materials.

This is already changing approaches to cabin design. Some fabrics are falling out of favour, for example, because it's impractical to sanitise them after every flight. There are also signs of a move away from darker colours and towards lighter colour schemes, and even all-white.

These trends mean there are more applications for our Zotek F OSU PVDF foams, beyond the huge savings in weight that have traditionally been the products' USP. Our newest grade – Zotek F OSU XR – is a case in point.

In what way?

When we set out to design XR we obviously had no idea that the pandemic was coming, but fortunately the whole idea of XR is

to extend the weight-saving benefits of Zotek F into new areas of the cabin.

Aircraft manufacturers already use Zotek F extensively for window seals, soft-touch trim, close-outs, insulation, carpet underlay and environmental control systems. It's light, easy to process and can be used to replace a whole variety of traditional aviation interior materials, including silicone, PU, composites and even some metal components. Its fire, smoke and toxicity ratings also meet all the relevant aviation standards, and the closed cell structure provides vibration dampening, thermal and noise insulation.

What we've added with XR are semi-structural capabilities, so manufacturers can now use it in locations such as the interior of seat pods, stowage lockers, rigid armrests and tray tables. In these areas XR can reduce weight by as much as 70 per cent on a like-for-like basis.

Because grades of Zotek F can be laminated together to create a single material that's rigid on one side and soft and flexible on the other, it can be formed into curves and complex shapes, so design teams have new opportunities to bring individuality and extra comfort to cabin interiors and the passenger experience.

90%

Some 90 per cent of the lifetime carbon footprint of a commercial airliner is clocked up during flying hours, so this is the key area of focus for sustainability

How does Zotek F OSU XR stand up to the more rigorous cleaning routines necessary today?

Like all Zotefoams products, XR is exceptionally chemical-resistant. This is down to the unique manufacturing process that produces a remarkably consistent closed-cell structure that acts as an excellent barrier to moisture. It is also unaffected by UV exposure, so fully compatible with sanitisation via UV-C.

How has Covid-19 impacted the business? Have you implemented new ways of working?

The pandemic has had a significant impact on the way we conduct our business, though fortunately staff have remained safe and healthy. We have manufacturing operations in the UK, North America and China, with a new

production facility in Poland nearing completion, as well as a sales and service office in India. Monitoring and managing different and dynamic circumstances globally is an ongoing challenge but we're grateful for the way our teams have adapted.

Our Chinese operation was closed briefly at the beginning of the year, in line with a local

During times of economic challenge forward-thinking companies take time to investigate better ways of doing things





1.5%

The lightest foam Zotefoams produces is MP15 FR in the Azote range, which weighs just 15kg/m³ and consists of only 1.5 per cent polymer, yet is suitable for numerous applications in aircraft cabins

government decree, but apart from that all our facilities have continued to operate, albeit with modifications in place.

The health and safety of our team is our priority and is central to decision-making. Staff who are able to complete some or all of their daily tasks elsewhere are working from home to reduce numbers on-site, with enhanced measures to ensure wellbeing.

For those whose roles are site-based, we continue to comply with evolving local guidance, implementing measures such as social distancing, additional PPE usage, limiting the number of visitors and putting in place regular screening, including temperature checks.

We're committed to doing everything possible to protect our team, our business and our customers' businesses, many of which are engaged in vital work to supply medical PPE.

How do you see the aircraft foams market developing in the near future?

It's clear that the reduction in air travel since the start of the pandemic will

impact the industry for some time to come. The number of commercial flights is approximately half what it was this time last year – although business jet charter appears to be less affected.

Also significant has been the collective realisation that we need to do more to address climate change – think back to all the coverage of reduced pollution levels during the 'global pause' in manufacturing and travel earlier in the year.

Zotefoams has a long history in a variety of markets globally, and during times of economic challenge there is a clear trend for forward-thinking companies to take time to investigate better ways of doing things in the future. This has been evident over the past six months with our aviation customers.

The number one trend is lightweighting. This reduces the CO₂ footprint of conventionally powered planes and increases the range of those powered by hydrogen fuel cells, which we've seen trialled recently. Some 90 per cent of the lifetime carbon footprint of a commercial airliner is clocked up during flying hours, so this is the key area of focus for sustainability.

Allied to lightweighting is material performance, and particularly the relationship between performance and density. The lightest foam Zotefoams produces is MP15 FR in our Azote range, which weighs just 15kg/m³ and consists of only 1.5 per cent polymer, yet

is suitable for numerous applications in aircraft cabins.

Compliance with standards – particularly fire, smoke and toxicity (FST) – is non-negotiable, and there's particular demand for qualified materials capable of fulfilling several uses, since these reduce both the bill of materials and the time and administrative burden associated with standards qualification.

Airlines and their suppliers have invested a lot of effort in assuring passengers that their risk of contracting Covid-19 is no greater in an aircraft cabin than elsewhere. Materials that do not support bacterial or viral growth are much in demand, as are those that can withstand a variety of enhanced cleaning regimes, from aggressive chemicals to UV-C exposure.

Finally, customer experience will be key as airlines compete to be the first choice for returning passengers. Clean interiors, with comfort and individuality achieved through soft-touch elements, are part of that experience and a natural home for aviation foams. These can be formed and finished in any number of ways and easily bonded to surface materials to create a luxurious yet lightweight finish. ☛



Above: Onboard comfort is achieved through soft-touch elements

Materials that do not support viral growth are much in demand as are those that can withstand enhanced cleaning regimes

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GE90: 25 YEARS STRONG

After GE Aviation's GE90 engine completed 25 years of service in mid-November, we look at some of the best facts and figures surrounding the milestone

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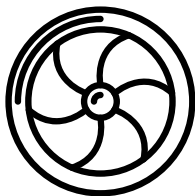
The GE90 entered service on the 777, powering a British Airways flight between London and Dubai.

2,800



GE has delivered more than 2,800 GE90 -94Bs and upgraded -115B engines to 70 operators around the world. The engine family powers all Boeing 777 models and is the exclusive powerplant on the 777-300ER, -200LR and 777F.

127,900



The GE90 engine held the world record as the most powerful jet engine for 17 years at 127,900 pounds of thrust until the newly certified GE9X engine achieved the new mark of 134,300 pounds.

123



At entry into service, the GE90 became the world's largest aircraft engine – the 123-inch diameter of the GE90 fan is approximately

equal to the diameter of the fuselage of a Boeing 727 airliner. It was also the first successful application of composite fan blades for a commercial turbofan engine.

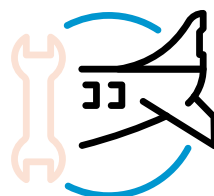
The engine has achieved the lowest maintenance burden to date, according to GE, through service bulletin terminating action acceleration and analytics-based field programmes.

99.97%

The GE90 engine has a dispatch reliability rate of 99.97 per cent.

100M

In July, the GE90 engine family surpassed 100 million flight hours.

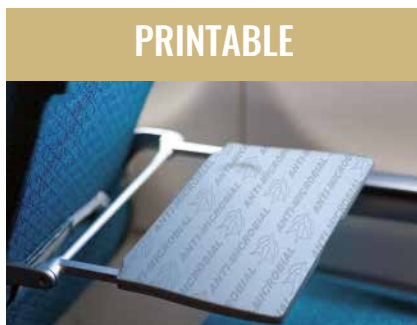


"We are excited to celebrate another GE90 milestone and would like to congratulate everyone involved in the engine's success," said GE Aviation's GE90 programme general manager Mike Kauffman. "We continue to deliver these extremely reliable engines and our dedicated product support team will maintain the GE90 for many years to come, providing maximum value throughout its lifecycle."

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