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# STATE of the INDUSTRY

CORONAVIRUS EDITION 2020



Ted Colbert

Martin Friis-Petersen

Dr. Johannes Bussmann

Russell Ford

Derek Zimmerman

Brian Rohloff



Philip Anson, Jr.

Jonathan Berger

Rich Phillips

Ryan Waguespack

Andy Hakes

Neil Book

Dave Marcontell

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May/June 2020

### TWINNING

DIGITAL TWINS ARE COMING INTO THEIR OWN AND BEING UTILIZED IN NEW AND INNOVATIVE WAYS



### ON GUARD

SAFETY EXPERT JEFF GUZZETTI EXPLAINS HOW A CESSNA 310 CRASH LED TO POSITIVE CHANGES



### HUMAN FACTORS

DR. BOB BARON TALKS HUMAN FACTORS TRAINING STIGMA



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+1 (920) 214 0140

### EDITORIAL

#### Editor-in-Chief

Joy Finnegan  
jfinnegan@avm-mag.com

#### Contributing Editors

Charlotte Adams  
James Careless  
Jason Dickstein  
Jeff Guzzetti  
David Jensen  
Douglas Nelms  
Dale Smith  
David Schober

### ADVERTISING/ BUSINESS

#### Publisher/Owner

Adrian Broadbent  
abroadbent@aerospace-media.com

#### USA Sales Director

Susan Joyce  
sjoyce@aerospace-media.com

#### International Sales

Jina Lawrence  
jinalawrence@avm-mag.com

### DESIGN/PRODUCTION

#### Lisa Garrison

lgarrison@avm-mag.com

### SUBSCRIPTIONS

#### Paula Calderon

pcalderon@aerospace-media.com  
+34 91 623 7969

### CLIENT SERVICES

#### Administration

Maria Hernanz Reyes  
maria@asi-mag.com

### LIST RENTAL

#### Statistics

Jen Felling  
felling@statistics.com

### REPRINT PARTNER

The YGS Group  
717 505 9701 x100



Aerospace & Security Media is a trading arm of ASI Publications Ltd

ASI Publications Ltd  
"Rydal"  
1 Coyners Avenue  
Southport  
PR8 4SZ  
UK

abroadbent@aerospace-media.com

[www.avm-mag.com](http://www.avm-mag.com) or  
[www.aerospace-media.com](http://www.aerospace-media.com)

UK Company registration no 5999781  
UK VAT no GB227106044

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## COVER STORY

### The State of the Industry

Each year we ask top maintenance sector leaders to share their insights about the state of our industry. See what these companies are doing to survive, prepare for the future and someday thrive again. Industry leaders from around the world share their thoughts.



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## 28 Twinning

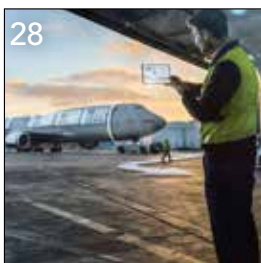
Virtual models, known as digital twins, can help refine maintenance and aftercare processes. But, they hold an even greater potential. Learn how individual parts and even processes can be twinned.

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Dr. Bob Baron says there is a stigma related to human factors training but there doesn't need to be. He gives advice on overcoming the stigma.



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Aviation Maintenance (ISSN 1090-221X) is published bi-monthly by Aerospace & Security Media Ltd, 2139 Oakview Rd. SE Atlanta, GA 30317. Application to mail at Periodicals postage paid at Atlanta, GA and additional mailing offices. POSTMASTER send address changes to Aviation Maintenance 2139 Oakview Rd. SE Atlanta, GA 30317. The editor welcomes articles, engineering and technical reports, new product information and other industry news. All editorial inquiries should be directed to Aviation Maintenance; Email: [news@avmain-mag.com](mailto:news@avmain-mag.com). Subscriptions: Free to qualified individuals involved in the aircraft maintenance industry. All other prepaid subscriptions, see [www.avmain-mag.com](http://www.avmain-mag.com). Content may not be produced in any form without written permission.

# Aviation Maintenance in the Time of Coronavirus

BY JOY FINNEGAN  
EDITOR-IN-CHIEF



In our annual State of the Industry feature, we ask top leaders in our industry to give us their take on where we are and where we are going as an industry. These leaders freely share their knowledge and wisdom with us so we can benefit from their expertise, experience and deep understanding of the market in which we work.

Asking for input this year was daunting. It's easy to share insights when the economy is booming, hangars and shops are full and backlogs are in the months or in some cases even years category. But now, more than ever, we need a reality check. Where are we as an industry? How bad is it? How bad will it be? Will the recovery be quick or take longer than expected? What should companies be doing right now to shore up their resources and protect their businesses?

Asking the biggest and best companies as well as crucial smaller players these questions at a time like this yielded amazing information. We are so grateful for all who took the time to share their thoughts and advice on this most unusual of circumstances that we find ourselves in. The coronavirus pandemic has flummoxed the industry. But these humble leaders found amazing thoughts to share and even encourage us with. Please read through our State of the Industry feature starting on page 16.

Let me share some highlights that leapt out to me. The first thing to jump out to me was from MTU's SVP Martin Friis-Petersen. After a massive slowing down of their operations for several weeks, the company is now beginning to ramp up again and using a philosophy they have hashtagged, #SmartNewNormal. The company says they will adjust shop capacity as needed, remaining flexible. Friis-Petersen commended the people of MTU Maintenance for their solidarity in the face of the current challenges.

StandardAero CEO Russell Ford says one

bright spot in their portfolio is their diversity of clientele. For example, he says their military work remains consistent, both with U. S. government clients as well as international military clients. As for the commercial sector, Ford says StandardAero is monitoring and managing the situation daily and "have contingency plans for quickly aligning operating costs with volume declines on an engine program-by-program and site-by-site basis."

Ever the realist, Lufthansa Technik's CEO, Dr. Johannes Bussmann, says the fact that many airlines have reduced flights by 90 percent will bring some airlines to the brink of survival and that the consequences to the MRO industry will be massive. He says they are doing everything possible to ensure the economic stability of their company while supporting their customers. In spite of the situation he concluded with a positive statement saying that he believes the aviation industry will "regain its former strength," and eventually grow again.

Derek Zimmerman, president of Gulfstream Customer Support says their facilities remain open and that they adopted new health and safety protocols. Zimmerman says some customers have used this time to do planned and scheduled maintenance. He adds as the travel restrictions are lifted, they believe more companies and individuals will see the benefits of business aircraft travel utilizing business jets.

STS Aerospace PJ Anson says first and foremost the safety of their employees is the number one concern of the company. Anson says managing their customer demand to their costs and cash burn is the biggest focus for the long term.

But he also believes companies that make decisions now to become leaner and meaner will ultimately allow a business to survive and even be more profitable.

One area of concern Andy Hakes, CEO

of AireXpert, points to is the expiration of the Coronavirus Aid, Relief, and Economic Security (CARES) Act which is providing economic assistance for American workers, families, and small businesses with the hopes of preserving jobs for American industries. Another area Hakes is focusing on is the continued viability of airline vendor networks and he says some smaller vendors may be facing crisis soon. He also says he is hearing the all too familiar refrain that companies will need to do more with less resources – but at an even more critical level.

The National Air Transportation Association is also bullish on business aviation once travel resumes, predicting a boom even. SVP Ryan Waguespack says businesses will be aiming to keep their people safe and will be using business jets as one way they do that. As for the commercial airline sector, Waguespack predicts a W shaped flight activity recovery period.

Boeing Global Services CEO Ted Colbert believes the work you do is key for people, communities, business, trade and "for the security and interconnectedness of our world." He says BGS is helping reconfigure passenger airplanes into freighters and working toward digital innovations that will help as operators lean out.

Management consulting firm Oliver Wyman released updates to their annual MRO Forecast just as we went to press. Dave Marcontell, partner, says air carriers "are facing extreme financial pressures and are cutting capacity at unparalleled rates," and they have revised their forecast for the MRO industry dramatically. One key piece of advice they give is that airlines and MROs need to figure out how to keep the key talent they have, so when the industry does turn around, they will have the experienced personnel needed. Turn to page 26 to read what the experts at Oliver Wyman are anticipating now and see more from their revised forecast. [AM](#)

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## Lufthansa Technik Shifts Focus in Response to Demand for Operational Changes from Pax to Cargo Aircraft

Lufthansa Technik says their new technical and engineering services for temporary operational changes from passenger to cargo aircraft have met with great interest. So far, the company's cabin modification team has received enquiries from more than 40 airlines. More than 15 projects for different aircraft types are already in the implementation phase. A special highlight is the support of the operational change of a first Airbus A380 of an undisclosed customer with which Lufthansa Technik has now been awarded.

"Over the past days, we have received strong interest from different airlines regarding our passenger to freighter service capabilities," says Henning Jochmann, senior director Aircraft Modification Base Maintenance at Lufthansa Technik. "As the workscope comprises much more than just taking out seats, you need engineering experts who know exactly what the challenges are and how to document the technical solutions so correctly that the aviation authorities agree. The current exemption and our solution for it can be transferred to our Supplemental Type Certificate (STC) at a later point of time without major adjustments. This means that anyone who opts for LHT's exceptional solution now can easily switch to the permanent STC solution later."

Normally, an aircraft that has been granted an approval for passenger transport cannot simply be loaded with cargo in the cabin, as the approval criteria for passenger cabins and cargo compartments are completely different, Lufthansa Technik says. For example, cargo has a different floor load, i.e. the structural load capacity of a passenger aircraft is lower than that of a



Lufthansa Technik is pivoting with the times to offer pax-to-cargo solutions.

cargo aircraft. While for passenger transport rescue routes must be kept clear and the oxygen supply must be ensured for each individual, special fire protection measures must be taken on board a freighter. All these criteria must be taken into account and incorporated into the technical documentation by suitably qualified engineers and approved.

Lufthansa Technik says they are currently working flat out to obtain STCs for all common aircraft types so that airlines all over the world can quickly convert their passenger aircraft into auxiliary freighters.

## Summit Aviation Celebrates 60 Years of Service

In 1960, Dwight D. Eisenhower was President of the United States, Johnny Cash played the first of his many free concerts behind bars, and on May 6, 1960, Summit Aviation, the oldest, continuous operating aircraft company in the state of Delaware was founded by Richard "Kip" Dupont.

In the sixty years since its founding, Summit Aviation has evolved into a full-service aviation center serving both domestic and international customers including the U.S. Government Department of Defense and International Military, U.S. Government Non-Department of Defense and Special Missions, general and corporate aviation, and state and local law enforcement. It was acquired by Greenwich AeroGroup in 2008.

"Summit Aviation boasts a long history of successfully serving its customers," said vice president and general manager for Summit Aviation Ralph Kunz. "We are extremely honored to carry on and expand the vision that Kip Dupont started with so long ago. We owe our success to that vision, our dedicated ownership, our customers, and the talented team of employees that have



Summit is celebrating 60 years of operation.

helped us grow and expand this company since 1960."

The company says it plans to celebrate with the community, customers and employees at a later date, in light of the pandemic.

## Field Aerospace Awarded KRACEn Contract

Field Aerospace was selected as an awardee on the Kits, Recovery, Augmentation, Components and Engines (KRACEn) Multiple Award Contract (MAC) supporting the United States Navy.

Commander, Fleet Readiness Center (COMFRC) awarded a 10-year, \$6.1 billion, enterprise contract vehicle to 42 small business industry partners on April 14, enabling U.S. Navy, government customers and international partners to procure aircraft maintenance services and sustainment support quicker.

The Kits, Recovery, Augmentation, Components and Engines—commonly called KRACEn—is an indefinite-delivery, indefinite-quantity (IDIQ) MAC that will provide maintenance services and support for single satellite sites, small aircraft quantities, personnel to augment government maintenance teams, and overhaul capabilities for aircraft components and subsystems. This is COMFRC's first, multi-billion contract award. The MAC's scope of work, which is set aside for small-businesses, includes modification kit build and installations, recovery of downed aircraft, repair and overhaul of aircraft and components, repair and overhaul of engines, and augmentation labor supplement for maintenance both ashore and afloat.

"As one of 42 small business industry partners, Field Aerospace will help enable COMFRC to effectively use the KRACEn enterprise contract vehicle allowing the Navy meet its sustainment needs expeditiously while delivering improved outcomes," COMFRC executive director Roy Harris said. "KRACEn is a crucial addition to our traditional organic capabilities, providing us with the means to tap into the expertise of small business industry partners."



Field Aerospace is part of KRACEn contract team for the Fleet Readiness Center.

The nature of the work covered by KRACEn—simple platform, organizational-level Contractor Logistic Services (CLS) requirements involving few aircraft, elemental or off-aircraft tasks—is well-suited for small businesses, according to COMFRC Acquisition Group, CLS Division Lead Chris Giggey. The CLS Division, formally known as the Fast Acquisition Solutions to Enable Readiness (FASTER) team, was chartered to improve acquisition speed and quality of services by developing expertise in CLS contracting.

"Field Aerospace is excited to be part of the KRACEn contract, ensuring readiness to our warfighters. Field is well-suited to perform under the KRACEn model as Field has the capabilities of a large business while maintaining the adaptability and agility of a small business." Matt Carreon, vice president of Field Aerospace explained.

## S7 Technics Launch Aircraft Engine Redelivery Service

In the current situation with the worldwide spread of the virus, passenger traffic has significantly decreased and many airlines have to return aircraft or leased engines. This often requires work on their long-term conservation, for the purpose of further storage.

Kirill Khilevich, sales director of S7 Technics aircraft engine repair services, thinks that this service has quite high demand and at the moment several requests have already been received from airlines for the complex service of performing redelivery on aircraft engines.

"Usually, this kind of work is performed on a removed engine abroad. The lease contract will not be closed until the engine is fully equipped, inspected and declared as serviceable," says Khilevich. "Our advantage is that we do all necessary work before returning the engine to the lessor. This saves time, money, and also allows you to close the lease contract and stop paying the rental fee."

Each engine is released with an EASA Form 1 certificate. It gives the opportunity to the next operator to install the engine on aircraft and continue its operation. The lessor can find a new lessee as soon as possible and continue to receive payments from the aircraft engine leasing.

All necessary equipment was purchased and currently available at S7 Technics home bases in Moscow and Mineralnye Vody. Up to three engine shop specialists required to prepare the engine for lease return. It takes about 3-6 days to complete the full range of works. The complex service of engine redelivery is also provided on the Customer's facilities.

S7 Technics' facilities are certified by EASA, Bermuda DCA, the Russian



S7 Technics is focusing on redelivery of aircraft engines that have been in storage.

Aviation Authority, and a number of other national aviation authorities to carry out maintenance for different types of Boeing, Airbus, Embraer and Sukhoi Civil Aircraft airlines.

There are three heavy maintenance bases located at Moscow (DME), Novosibirsk (OVB) and Mineralnye Vody (MRV) airports and several line maintenance stations across Russia. Company holds EASA-145, EASA 147, EASA-21G&J approvals as well as Bermudan, Russian and some other countries certificates. S7 Technics' Moscow (DME) base is ISO certified under EN 9110:2016 quality system standard.

## ILS and Component Control Launch ILS Bridge for Quantum

ILS and CCI are excited to launch the ILS Bridge for Quantum. This new solution will allow automated listing of Quantum Inventory on ILS and provide real-time connectivity between Quantum Control and ILS, the world's leading digital aerospace marketplace. The solution will be generally available as of today.

"Mutual Quantum ERP and ILS customers have asked for this capability given the criticality of both systems in our customers' aviation supply chain," says John Herrman, EVP and GM at ILS. "This integration solution will connect our software platforms and begin unlocking the combined value of our platforms", says Todd Lewis, President and GM of Component Control.

The ILS Bridge for Quantum is a fully integrated, real-time connectivity solution that simplifies inventory and RFQ management for buyers, provides robust out-of-the-box functionality, and enables intelligent supply chain management with improved data integrity. Functionality sets include;

- Easy selection of inventory and stock lines for auto-posting to the ILS Marketplace, providing customers the choice to list all of their inventory or only selected items. As customers use the bridge to automatically refresh their verified inventory, ILS adds value to the search ranking, and gives those customers a greater opportunity to be on the first line of the ILS search results.

- Efficient issuing of RFQ's and purchase Orders directly through Quantum, including automated response management, allows customers to issue RFQs to selected vendors within ILS and use Quantum Control to manage the RFQ responses.

According to Tim Hernandez, I.T. Manager at Pacific Southwest Instruments "The ILS Bridge for Quantum reflects the forward thinking approach companies like PSI expect, and as a long-standing ILS and

Quantum Control user, we appreciate that CAMP Systems listens to their customers and is delivering on our needs to create more synergies between these software platforms."

Said Sean Lanagan, President of Enterprise Information Systems of CAMP, "when we acquired ILS, our goal was to provide a superior experience to customers by integrating ILS with our other software platforms. This is the first step, quickly delivering on that goal, and there is more to come, including a real-time integration with CORRIDOR. We are committed to developing a software ecosystem that helps the aviation industry achieve ever higher levels of efficiency, profitability and safety."

In addition to the ILS Bridge for Quantum announcement, ILS also announced further improvements to the Parts Watch and Catalog products, providing improved customer benefits e.g.

- Parts Watch now monitors for PMA equivalents, automates RFQ triggered response, and allows users to predefine condition codes and select geographical regions

- Catalog functionality allows customers to create catalogs directly from their inventory listed on ILS with integrated links back to the customers' website and ILS marketplace search integration.

Today the solution will be available for review and demonstration via an on-demand webinar.

"ILS and Component Control have worked very closely with their customers to develop solutions that streamline their supply chain. In today's aviation market conditions this is especially important, as our customers want to ensure their parts needs or inventory supplies are updated accurately in real-time so that their prospective partners can do business with them without any concern for data- or inventory integrity," say Herrman and Lewis.

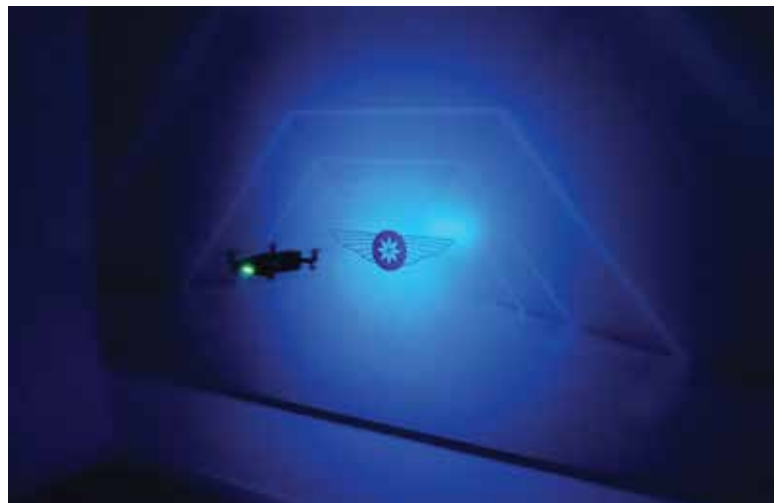
## Aeronautica SDLE and Grupo Rías Prepare a Micro Drone for Disinfection with Ultraviolet (UVC)

Spanish companies Aeronáutica SDLE and Grupo Rías are developing a micro drone emitting ultraviolet light (UVC) to disinfect surfaces and indoor and outdoor areas. The drone will provide quick and effective sterilization that ensures the elimination of the coronavirus essential to stopping its spread. The latest medical studies have verified the virus can remain active for up to 72 hours on certain materials such as plastic.

C-band ultraviolet light system (UVC) is highly effective and applied from a micro drone of these characteristics, it can disinfect large areas in a few minutes. This micro drone is being manufactured for this purpose, works with sensors that allow it to perform its function remotely inside buildings and avoid human exposure to the risk of infection. The drone will have 15 minutes endurance, when charged.

Virus removal by ultraviolet light is 99.99% effective on both surfaces and in the air, making it the most recommended technique by health authorities to prevent coronavirus in hospitals and all its rooms, public spaces, offices, industrial buildings, etc., disinfecting more effectively compared to manual cleaning and disinfecting spray solutions.

Ultraviolet light works by deactivating the DNA of pathogens, which guarantees that disinfected spaces can be occupied



A drone emitting ultraviolet light to disinfect surfaces is being developed by two Spanish companies.

immediately after cleaning, without any exposure to the virus or to any product that is aggressive for health or the environment. "Robots do not replace people, but they are capable of performing tasks that a person could not safely do, complementing human endeavors and playing a notable role in almost all aspects of crisis management," the two companies say.



## Conversion of A350 for Germany's Special AirMission Wing Begins

Lufthansa Technik has begun working on the cabin conversion of the first of three Airbus A350-900s for the German Federal Government's Special Air Mission Wing. The aircraft with the temporary civil registration D-AGAF (later military registration 10+03) have arrived at Hamburg's International Airport in Fuhlsbüttel where it will be given a government cabin by Lufthansa Technik's VIP & Special Mission Aircraft Services product division. This is the world's first



conversion of this kind of an Airbus A350.

As this aircraft is to be made available to the German Air Force very soon, it will initially be equipped with a special transitional cabin for the transport of representatives of the Federal Government and their accompanying delegations. The corresponding preliminary work had already begun in November last year in Lufthansa Technik's VIP workshops. Once the aircraft has received its cabin, it is scheduled to be delivered to the customer by the end of July.

The transitional cabin is tailored to the specific requirements of the customer. It will be equipped with office and conference areas, adjoined to a multifunctional lounge area. The rest of the cabin space will be available to the accompanying delegations. It will have generous seat spacing, an appropriate number of washrooms and modern kitchen equipment.

Only after the sister aircraft 10+01 and 10+02, which are currently still under construction, receive a fully featured VIP cabin from Lufthansa Technik next year, the transitional cabin in 10+03 will also be exchanged for one.

"Over decades we have formed a comprehensive partnership with the German Air Force, in the course of which we have already equipped a large number of aircraft with special cabins for government representatives," said Kai-Stefan Röpke, vice president VIP & Special Mission Aircraft Services. "Today we are of course particularly pleased to be able to extend this cooperation to the most modern generation of aircraft and to install the first government cabin in an Airbus A350. This is not only a first for our long-standing customer German Air Force or for Lufthansa Technik, but for the entire industry."

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## ATP Casebank Rebrands as ATP Emphasizing Key Components, Strong History

Aircraft Technical Publishers and CaseBank Technologies Inc. have rebranded to become known as ATP, a leading provider of information services and software solutions for the aviation industry. The company is also introducing a new logo and tagline which celebrates their nearly 50 years of history within aviation, and their commitment to aircraft safety and reliability.

Aircraft Technical Publishers, the leading provider of maintenance and regulatory information and the cloud-based ATP Aviation Hub and ATP Libraries platforms, will now be marketed as ATP Information Services. CaseBank Technologies Inc., the developers of the ChronicX defect analysis and SpotLight guided troubleshooting platforms, will now be marketed as ATP Software Solutions. Combined, the new ATP has more than 6,700 customers in 137 countries globally, and services four key verticals within the aviation industry – OEMs, general aviation, commercial aviation, as well as military and defense.

Effective mid-April, the company began using their new logo and tagline. They say the logo was designed to “honor the rich history of the two companies within the aviation industry while also being a bolder and

more modern representation of the future opportunities ahead.” The new tagline “Always Ready” represents the commitment of the company to its customers and the broader industry, while also being the mantra of ATP’s dedicated employees in delivering services and solutions.

“When you undertake a project to rebrand a company with this degree of experience in the aviation industry, the task at hand requires an extreme degree of thought and care,” notes James Geneau, chief marketing officer at ATP regarding the launch. “ATP’s solutions and services can be found in every corner of the aviation world. From a single propeller crop-duster in Iowa to the cabin of a passenger jet or supporting the mission of an F-35 Joint-Strike Fighter. We are dedicated to aviation, and this new brand strategy reinforces that we are always ready to make flying safer and more reliable.”

In addition to the launch of a new company website and social media channels, ATP says it will be launching a campaign over the coming months to reintroduce the industry to the new company. To learn more about the new brand and company vision, a dedicated webpage has been created at [www.atp.com/alwaysready](http://www.atp.com/alwaysready).

## Nypels Joins APOC Aviation’s Engine Trading Team

APOC Aviation has brought Jim Nypels into its new engine trading division as the organization prepares for a return to increased leasing and trading activity. Nypels has been with APOC since the start of the business in 2015. After a period as warehouse and logistics manager he moved to project management focusing on airframe teardowns – a core activity for the innovative leasing, trading,



aircraft component and part-out specialist.

“At this challenging time for the aviation industry I am currently concentrating on engine valuations and preparing for the integration of the Company’s engine platform on its proprietary software ‘Alicanto’. Our guiding principle at APOC is to leave nothing to chance so we are devoting a great deal of investment and time into the development of the engine module within our best-in-class IT platform. Contributing to these new developments and undertaking training from our technical department will help fast-track my engine knowledge,” he says. “We have big plans for APOC’s Engine Trading division.”

## Elliott Aviation Touts Guaranteed Four-Week Citation Excel/XLS Garmin G5000 Installations



Elliott Aviation announced a \$3,000 per day guaranteed four-week downtime on standalone Citation Excel/XLS Garmin G5000 retrofits. Elliott Aviation has delivered 12 Garmin G5000 equipped Citation Excel/XLS aircraft already. In addition, Elliott

Aviation offers free avionics familiarization with all Garmin G5000 installations at their headquarters in Moline, IL.

The Garmin G5000 for the Citation Excel/XLS replaces all existing Honeywell Primus 1000 avionics, including the autopilot and flight director. The retrofit has WAAS/LPV, ADS-B, XM weather, electronic charts, SafeTaxi, engine monitor data, and emergency descent mode. It also has optional synthetic vision, turbulence detection, SurfaceWatch, underspeed protection, Chartview, CPDLC, and lightning and hail prediction. Elliott Aviation says they have completed more Garmin full cockpit retrofits than all other dealers in the world, combined. They have installed more than 50 total Garmin G5000 systems in the Beechjet 400A/Hawker 400XP and Citation Excel/XLS, and over 350 Garmin G1000/G1000 NXi systems in King Airs.

“As we continue to lead the industry in Garmin G5000 retrofits, we wanted to offer customers the peace-of-mind that comes with a guaranteed four-week downtime,” said Conrad Theisen, director of Avionics Sales at Elliott Aviation.

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## Modified ZERO Abrasive-Blasting Cabinet Helps Streamline Work



ZERO BNP-7212 Suction Blast Cabinet.

Recently, Clemco delivered a modified ZERO BNP-7212 Suction Blast Cabinet to MB Aerospace's facility in East Granby, Conn. MB Aerospace manufactures and repairs aero-engine components. It has five facilities in Europe and one in Asia, as well as its three U.S. locations.

"This cabinet will be our repair shop's primary method for cleaning parts from the field," says Timothy Clark, MB Aerospace senior manufacturing engineer. "We overhaul ground turbine components

in this area of the shop, but first we have to clean engine residue, scaling, oil, etc., off the parts so that we can inspect for cracks and other wear issues."

More than 160 welders, fabricators, and technicians work in the shop and factory. "The guys were immediately impressed when the cabinet arrived," Clark recalls. "First off, it's a monster. Basically a seven-foot cube for a work chamber. But after inspecting the cabinet and using it, people have all commented on how impressed they are with the quality of the welds and the workmanship in the cabinet, and the high-quality material used to construct it. The cabinet is operating exactly as intended."

In addition to the extra-large work chamber, this modified BNP-7212 is fitted with a 66" rotating turntable that tilts at 30° and 45° angles for pinpoint blasting. The cabinet also is equipped with a 1200 CFM reverse-pulse dust collector and a 1200 CFM reclaimers.

The components that MB Aerospace blasts with the cabinet range in diameter from 36" to 72", and in weight from 150 lbs to 350 lbs. Before receiving the cabinet, MB Aerospace sent parts out for cleaning with a typical turnaround of about one week.

"This morning we cleaned a part in only three hours," Clark says. "This included setup and shutdown of the cabinet, loading and unloading the part, and a wash cycle after the blasting. This is a huge timesaver for us—from one week to a handful of hours. It helps us control our own destiny by using fewer outside vendors and working more in house."

## ACTSI Achieves 4A/4C Check on Gulfstream Fleet

Philippines-based Aviation Concepts Technical Services, Inc. (ACTSI) announced a recently upgraded 4A/4C capability from Federal Aviation Administration (FAA) following the preliminary 1A/1C approval received in the middle of March. The ACTSI MRO is now capable to provide maintenance services for Gulfstream G450, G550, G650 & G650ER. ACTSI added the Gulfstream G280 at the 1A/1C level.

ACTSI has also completed the process of matching the FAA Approvals to Bermuda and Cayman Aviation Authorities, increasing our support for those registered aircraft. "I am extremely proud of our team who have maintained their focus during this challenging time, and worked so hard to expand those capabilities," commented Mr. James Hill, COO of ACTSI. "We managed to work collaboratively with not only the U.S. FAA Inspectors remotely but also the Cayman and the Bermuda Inspectors."

ACTSI, a newly refurbished facility for aviation maintenance, repair, and overhaul (MRO) services recently opened at the Subic Bay International Airport (SBIA), with the



goal of transforming the former US Navy base into a 24/7 hub for business aviation in the Asia Pacific.

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## IAI, Microsoft, and Soroka Medical Center Collaborate to Create “Cockpit” System for Patient Data Collection in the COVID-19 ICU

As part of the mobilization of state-owned companies in cooperation with Administration for the Development of Weapons and Technological Infrastructure (MAFAT) and the State Companies Authority to address the COVID-19 pandemic, Israel Aerospace Industries (IAI), Microsoft, and Soroka Medical Center have collaborated to develop a supervision system that makes it possible to collect data on ventilated COVID-19 patients in a single location while providing updated, comprehensive information on patients’ status while minimizing the exposure of medical teams to infection.

The system integrates data from all systems and sensors and performs data cutting and extraction to monitor measures, identify trends, and generate early warnings using artificial intelligence measures. The system makes it possible to streamline

the support of Microsoft in Israel, using Azure Data Explorer for real-time data ingestion and data analytics services to analyze and display patient data and video streaming services to visually display patients.

The development makes it possible to supervise a large number of patients simultaneously, as millions of events can be transferred and displayed in the system per second.

“When treating COVID-19 patients, maximum protection of the medical staff is required. One of the most significant challenges we face in treating these patients is the need to minimize physical contact between healthcare providers and patients. We must move to maximum use of remote means of treatment,” Dr. Shlomi Codish, director general of Soroka Medical Center says.

“The digital means, the remote viewing of monitors, respirators,

infusion pumps, and other devices connected to the patient, enable us to maintain maximum distance and ensure maximum protection for medical staff. We thank Israel Aerospace Industries for their cooperation and for their support of the medical teams that are at the forefront of the battle against the virus and thus assisting them in providing quality medical care while ensuring the safety of the staff.”

Prof. Yaniv Almog, head of the Internal Intensive Care Unit for COVID-19 patients adds, “The great advantage of the system that was developed is its ability to simulate the routine situation in which I enter the room, see the patient, and collect data from all the devices around him.



Israeli Aircraft Industries collaborates with healthcare groups to create a system to monitor COVID-19 patients.

processes, learn, and produce data.

The data collected is made available for various needs to the medical staff in the control room, a kind of “cockpit” from which remote doctors’ rounds, regular patient management, task management in the ICU, and device management can be carried out.

Data sharing provides access to all the data from near and far, utilizing the various resources available inside and outside of Soroka. The data is secured in accordance with most stringent standards of medical data protection. The characteristics of the system were defined and determined in preliminary meetings between the team of developers and the staff of Soroka’s Internal Medicine ICU.

The system was demonstrated to Dr. Shlomi Codish, director general of Soroka Medical Center, Yarden Nevo, associate director general of Soroka, Eran Barabi, director of the Computing and IT Unit, and Prof. Yaniv Almog, head of the Internal Medicine Intensive Care Unit for COVID-19 patients.

The system was developed on Microsoft’s Azure platform with

This is an important advantage that will allow us to cope safely and comprehensively with patient care management even in the era of COVID-19. I see benefits and the potential for widespread use of the system in the future as well. By means of its early warning capability and its ability to collect large amounts of patient data at early stages of the disease, we can produce a system that warns us of possible deterioration in a patient’s condition, so that we can respond earlier and possibly prevent it.”

Yoav Turgeman, executive vice president, IAI and CEO of Elta comments, “The IAI has joined the fight against the coronavirus, and in addition to its ongoing business operations, in recent weeks has developed numerous technologies that assist medical teams and patients in hospitals. Elta brings to Soroka Medical Center knowledge and experience from the worlds of intelligence, cyber, radar, and artificial intelligence, the Aviation Division of the IAI brings its knowledge of supervision and control systems and data collection from the world of aviation, and together with Microsoft, we combine technologies for the monitoring of patient measures, department management, and device control, all without the need for human intervention. We will continue to support the national effort to find effective and innovative solutions. And together we will win.”

## Stertil-Koni Debuts Heavy Duty Shop Equipment Line



Heavy duty vehicle lift maker Stertil-Koni announced liftoff for its expanded line of shop equipment – in this case several key systems engineered specifically for the aviation sector.

Two of the initial products in the expanded Stertil-Koni line of heavy duty shop equipment work in conjunction with one another to assist technicians in performing brake and tire repair as well as landing gear maintenance and servicing.

The products are a hydraulic wheel dolly for aircraft wheels and tires (Model SKWTA500) – with a capacity of 1,100 lbs.; an air/hydraulic commercial aircraft jacks for main landing and nose gear (Models SK65-1AP and SK25-2AP) – with capacities of 143,000lbs. and 55,000 lbs. respectively. “We are a well-established company that is exclusively focused on heavy duty lifting systems,” Dr. Jean DellAmore, Stertil-Koni president, says. “What’s more, Stertil-Koni has a recognized track record supporting the ground service equipment industry and these new offerings are in direct response to customer needs. We look forward to more fully supporting the overall aviation sector with our high capacity, efficient, safe and ergonomic offerings.”

## BriskHeat Partners with GMI to Distribute Composite Repair Products

BriskHeat is partnering with GMI AERO to distribute two composite repair products used by aerospace manufacturers. Designed for the repair of high-performance aircraft structures, the Anita bonding console is a portable system for smart patch repair bonding in the field. Optimized for ease of use by shop technicians, the Anita EZ09 features a large touch-screen display panel and sophisticated software. It contains all the necessary functions to control the bonding heating process under vacuum for the repair of composites or metal structures. Dialogues are available in English, French, Spanish, German, Italian, Russian, Chinese or Japanese.

GMI’s Leslie Composite Repair Kit contains the necessary tools for composite repair on an advanced carbon structure. The kit materials can also be used on fiberglass and Kevlar. Contents of the kit allow for full preparation of all repair phases, including removing the paint, preparing the installation of the core and patch, drying the area with a foldable oven, routing and stepping the skin, handling wet lay-up operations, manufacturing the patch and installing it, and making the vacuum bag. Heat blankets (not included) are also available separately through BriskHeat. “We’re pleased to announce our partnership with GMI, a pioneer in integrated equipment for advanced process control,” said Chad Goines, manager of North American Direct Sales,



BriskHeat. “By providing our customers with the option to purchase the Anita hot bonder and the Leslie Composite Repair Kit, we further flesh out our offerings to meet the needs of manufacturers in the airline and MRO industries.”

## Commsoft Announces Restructuring for Future Growth

Communications Software (Commsoft) has announced a management restructuring program which will position the company for future international growth. Patrick Cusk joins the Commsoft team as president. Cusk is also vice president of Operations at Valsoft Corporation (which acquired Commsoft last year) and has a background in vertical software applications, structured finance and commercial law.

John Wilson has been appointed as the new director of Technology. Wilson was previously COO at Black Ball Solutions and has a deep understanding of the aviation industry and Agile methodology.

As part of the new management restructure there have been a

number of internal promotions. Pete Lambert has been promoted to Director of Operations. Lambert was previously head of Technical Operations and has been at Commsoft for 21 years. Julian Beames has been promoted to head of Customer Accounts. Beames was previously business development manager for nine years.

After twelve years of leading the business, Nick Godwin is moving on from his role as managing director and will remain in close partnership with the business moving forward. As a senior consultant, Godwin will be assisting the team with sales and global new business opportunities and continuing to provide Commsoft with the benefit of his extensive market knowledge and experience.

# STATE OF THE INDUSTRY

by Joy Finnegan



Omaha's Warren Buffett sold out of the airline sector at a loss at the beginning of May. Buffett is quoted as saying he thinks the airline business has changed and has a hazy future. Investors took the move as a bad omen. Buffett usually touts the long view of buying and

holding. Revenues are predicted to drop by half or more, according to the International Air Transportation Association (IATA). Airlines are retiring fleets considered not a good fit for their current operational needs. American has officially retired the Embraer E190 and Boeing 767 fleets and the airline is speeding up the retirement of its Boeing 757s and Airbus A330-300s. Planned gradual phase outs of the Boeing

747 and Airbus A380 by airlines are over — they're out. Delta announced they will retire their B777 fleet. Some say these retirements are not as worrisome as they may seem and were already planned for anyway. Southwest Airlines says it is losing \$30-35 million per day and predicts that to continue through June. American Airlines reports they have stanchied their daily losses to \$50 million per day. All the airlines are now in survival mode as opposed to minimize loss mode.

Delta Air Lines CEO Ed Bastian says he believes the industry will take two or three years to recover. All of this leads us to our current situation in MRO. Everything starts from here and will impact MRO. Read on to learn how MRO leaders and industry consultants around the world think we are doing now and what lies ahead.



## Ted Colbert, President and Chief Executive Officer Boeing Global Services



Ted Colbert

### WHAT IS THE STATE OF OUR INDUSTRY?

The commercial aviation industry is truly facing an unprecedented set of challenges, and that means a significant near-term market contraction for commercial fleet maintenance and services. It's a challenge like nothing we've faced before, but I remain optimistic that a recovery

will come. The work we do is too important for people and communities, for business and trade, and for the security and interconnectedness of our world.

Airline customers have an immediate need for fleet storage and re-activation support, as well as engineering support to adapt passenger airplanes into freight transport configurations.

Boeing is providing up-to-date technical information to ensure appropriate preservation and protection measures are in place for storage, which is the foundation for service re-entry.

We're also coordinating closely with our customer support team to help reconfigure passenger airplanes into freighters, as fewer passenger flights mean less freight is being transported in the belly of the airplanes during those flights. This continues a trend for greater market demand for freighter aircraft.

Helping customers adjust their operations in favor of cargo transport is one of the ways our industry is helping support the fight against the pandemic by delivering much-needed medical

supplies and equipment to support the healthcare industry.

Digital offerings also continue to emerge as critical enablers for airlines as they adjust to future market demands and develop leaner operations. Many airlines and maintenance operators will look to digital solutions to help increase efficiency and reduce operating costs as air travel slowly resumes. Navigation and charting software will be important for new route structure planning, and crew rostering and planning software will similarly support resized operations staffing.

Looking forward, we also see used serviceable materials (USM) playing an important role in supporting the industry's increase in operations, as consumption of refurbished parts is expected to increase. Many commercial aircraft and engines will not be going back into service and will transition into the teardown market. As a result, USM creates an opportunity to apply our platform lifecycle experience to help airlines and MROs reduce costs while maintaining operational efficiency. And we're ensuring that we have the resources and inventory to support our customers' increased demand for quality USM parts, both Boeing proprietary and non-Boeing parts.

Even as we grapple with this challenging near-term outlook in commercial aviation and position ourselves for future changes in the industry, our team is stepping up our support for and partnership with government customers. We remain focused on supporting their missions and fleet readiness levels through our integrated service capabilities. One important focus area is our work in partnership with our customers to create a more predictive maintenance environment through the application of data analytics.

These are challenging times, but I'm proud of how our industry has come together to holistically address the need for new technologies to enhance safety, collaborating in areas where we can to innovate and find creative solutions that will help the flying public to return to the skies at levels akin to what we saw prior to the crisis. This shared goal is ultimately how our industry will weather this storm.

## Martin Friis-Petersen, SVP MRO Programs MTU Aero Engines



Martin Friis-Petersen

**THE AVIATION INDUSTRY IS IN UNCHARTED WATERS. THE INDUSTRY HAS GONE FROM BOOM TIMES WITH BILLIONS IN PROFITS TO THE BRINK OF DISASTER IN THE COURSE OF A FEW WEEKS. WHAT IS YOUR COMPANY DOING TO WEATHER THIS UNPRECEDENTED TIME?**

During March and April, we ramped down operations to emergency staffing level at our facilities in Hannover and Berlin for a three week period. This was both to protect our employees but also as a result of difficulties in the supply chain. We are extremely proud of our team who maintained minimum service levels, carried out AOG services and received and delivered engines and parts during the ramp down. This minimized disruption for customers, in particular those operating vital cargo transport.

We are now ramping back up to a #SmartNewNormal. We intend to flexibly adjust our MTU Maintenance shop capacities to meet demand going forward. As we have the largest engine MRO portfolio worldwide and service many programs at multiple locations, this ensures our availability to service our diverse customer base and meet their needs and requirements. We are monitoring the supply chain situation, COVID-19 developments and different regional trends daily.

### **WHAT ARE YOUR PREDICTIONS ABOUT HOW THE AVIATION MAINTENANCE INDUSTRY WILL RECOVER?**

As the situation is continually evolving, this is hard to predict exactly. However, it is notable the flight data has stabilized on low levels with slight improvements regionally – mainly supported by increase in domestic travel. Recovery of international travel will depend on how long regulatory travel restrictions are upheld. Nonetheless, we believe that all industry stakeholders need to come together and support the perception that that flying is safe.

MTU is contributing to helping our industry get back up on its feet. We are providing customers with innovative and cost-effective engine service solutions to facilitate the smooth airline re-start that we expect will gradually evolve from the second half of 2020 onwards.

In addition, we continue to partner with customers regarding cost-improvement measures, so that we can support their ramp-up in operations. These measures include intelligent repair solutions, flexible lease services and sourcing teardown engines as well as used serviceable material.

### **WHAT DO YOU THINK THE LONG TERM IMPACT OF THE PANDEMIC WILL BE?**

We are sure that the mid and long-term prospects for the aviation industry remain positive and an uptake will be seen again. All previous crises have shown that the need for mobility and the desire to travel returns. At present, no one can accurately predict how long this will take. In turn, it is even more important to maintain a highly flexible organization that can adjust quickly to market development and opportunities. We are optimistic that after the current downturn, the aviation industry will grow again, and our business base with it. At MTU, we have a broad and predominantly narrowbody MRO portfolio. This combined with our regional spread and diversified customer base means we are highly confident we will emerge from this COVID-19 crisis in due course.

### **PLEASE GIVE US YOUR SILVER LININGS AS WELL – WHAT ARE THE POSITIVES THAT HAVE COME OR WILL COME OUT OF THIS UNUSUAL TIME?**

The positives are definitely the people. Firstly, our own staff, who have done and continue to do everything in their power to keep the virus out of our facilities remaining highly disciplined and still maintain services for customers. There is a huge sense of solidarity in the face of current challenges and in combatting those to come.

But this also applies to our customer relationships: we have always seen ourselves as partners to our customers, and this will be even more true moving forward. We will work together to find flexible and reliable solutions that work for all sides given the current constraints and limitations we all have, going above and beyond if necessary. We greatly appreciate the trust, support and interest in our employees' wellbeing that we have received so far.

## Dr. Johannes Bussmann, CEO Lufthansa Technik



Dr. Johannes Bussmann

### **WHAT IS THE STATE OF OUR INDUSTRY?**

"The last few months have clearly shown how volatile and vulnerable the aviation industry is. Even as the MRO side is normally more robust when crisis happens in parts of the world, it hits us this time much harder than in the past.

The heavy impact of the coronavirus crisis on international aviation and the MRO business is obvious. Travel restrictions, the cancellation of trade fairs, conferences, business and private trips have forced

many airlines to cancel flight connections and to ground their aircraft by 90% and more. This additional burden will bring many customers to the brink of survival, and not every airline will survive. Because even if the crisis peak should be passed sometime in the next few weeks, it will probably take years to get back to normal flight business. This means that operations will be reduced, fleets will become smaller, older, more maintenance-intensive aircraft will be decommissioned, and air traffic as a whole will take a long time to return to pre-corona levels. Under these circumstances, the consequences for the MRO industry will be massive, too. We already see them in our own shop floors and in a consequence have already introduced various measures to mitigate potential operational and economic effects.

We have taken care of all required health measures in our shops based on recommendations of the German Robert Koch institute to ensure an adequate working environment from the health perspective. We have put cost saving measures in effect such as a massive reduction of business trips and internal events, etc. In addition, we have imposed a full hiring freeze and terminated the contracts for almost all temporary workers who hence had to return to their respective agencies. We also have introduced short-time work at our German facilities to react to the lower workload.

Despite these measures we have set up a special organization to secure and continue our business operations for our customers around the world, not only with regard to MRO services but also with regard to a stable supply chain.

Our international network with our diversified portfolio is paying off in this situation, as we are recording significant workload declines in various business areas, but other areas are still running quite stable.

For example, our Landing Gear division currently is still operating at a good capacity, mainly due to demand from customers offering cargo flights. Our VIP & Special Mission Aircraft division is working on a "close-to-normal" level. And in the engine services sector, we still see a decent demand for our Mobile Engine Services product. Here we offer various MRO services for engines that are primarily performed on-wing or on-site at the customer's premises. This makes it possible to avoid or at least postpone the odd cost-intensive overhaul in an engine shop. And last-but-not least the current developments in China could mean that the peak of the corona crisis has passed there. Hopefully, this will soon have a positive effect on our regional business. In any case, our subsidiaries and joint ventures in China are already operating almost back to pre-crisis levels.

A well-founded forecast about the further development of our industry is impossible at the present time. There are still daily new restrictions and reductions in international air traffic. While the peak of the corona crisis may be over in parts of Asia, it isn't in Europe, North America and other regions. No one currently knows when air traffic will return to a more or less normal level. Because even if the health risks of the current crisis should be under control again in the next few months, it will take a long time before the demand for flights rises again significantly and with it the demand for MRO services. I do not

believe that we will still return to business as usual this year. But we are doing everything necessary and possible to ensure the economic stability of our company in the medium term and at the same time to be able to offer our customers secure logistics chains and reliable technical services.

But to conclude with a positive statement, I am firmly convinced that the aviation business will regain its former strength in the medium term and return to a solid growth rate. It is important to survive the next months or even the year 2020 and 2021 economically and at the same time to prepare for this post-corona phase now. It will offer us and other strong players good opportunities for positive business development in order to offset the negative impact of the current crisis as quickly as possible. Our early investments in all new aircraft types will proof positively, as on a global basis the fleet will get younger in average in the mid-term. Even if money for new aircrafts will remain tight for a while, which is likely to be the case."

## Russell Ford, Chairman & CEO of StandardAero



Russell Ford

### WHAT IS THE STATE OF OUR INDUSTRY?

Regarding the COVID-19 pandemic, our first priority is continuing our full focus on following all guidance and precautions to safeguard our employees, customers and communities. All of our global sites and facilities are complying with published guidelines from recognized public health

and safety resources and planning for deployment of additional measures as we closely monitor the situation.

COVID-19 business impacts have varied across our different market segments. The natural hedges created by our portfolio of commercial aviation, business aviation, military, helicopter and component repair businesses have given us some insulation from the more immediate dramatic impacts on global airlines and OEMs. Our backlog on certain engine programs and the normal lag time of aftermarket activity has also allowed our shops to remain active on the front end of the pandemic's impact on North America, in particular.

As far as any signs of bounce back in specific geographies, we are not seeing any near-term positive impacts. Though we believe it is incredibly difficult to forecast in the current environment, we do agree with the methodology and many of the conclusions coming from industry experts based on past crises and profound worldwide traffic declines beginning in late March, which suggest that commercial traffic will take two-three years to recover to 2019 levels.

Following is our current view on how COVID-19 is affecting

each of our MRO market segments.

Commercial aviation is clearly the hardest hit, and we expect to see a direct impact to our commercial engine MRO volumes. Despite steep declines in certain turbofan engine volumes, our backlog and pipeline for regional jet and turboprop engine MRO is steadier, but we see signs of declining demand. We are managing this situation daily and have contingency plans for quickly aligning operating costs with volume declines on an engine program-by-program and site-by-site basis.

After a strong Q1, our Component Repair volumes have also been impacted. As a positive offset, we have seen some potential new business opportunities from customers who previously sent work to other shops that are now closed.

In Business Aviation, we have seen strong pipeline of volumes and have experienced unanticipated improvements in scheduled bookings and even higher inputs than planned prior to COVID-19. Many business aviation operators are using this downtime as an opportunity to bring their assets in for early maintenance. Our MRO shops are continuing to schedule work over the next couple of months, but we anticipate volumes declining as 2020 progresses.

Our Helicopter MRO services remain steady state on certain military engine platforms, but we are seeing significant declines on civil engine platforms and airframe mods.

In our Military market segment, the U.S. government services have not indicated any decrease in military sustainment or operating tempo. Inputs are steady and forecast MRO volumes remain consistent despite the COVID-19 situation. Likewise, international military customers have not signaled any decreases in future demand. We are expecting our military MRO shops to continue operating in a normalized fashion.

Prior to COVID-19, we were in expansion mode in all of our business units and hiring many new technicians at virtually all of our sites globally. We have grown in North America and Europe purposefully to establish ourselves in these mature, but growing markets. Additionally, we had been considering numerous opportunities to grow in emerging economies like Asia-Pacific or Latin America, especially as the majority of future aircraft deliveries and subsequently, maintenance requirements will create opportunities for companies like StandardAero.

Looking ahead to the future, the operating model for an MRO company will likely require a more effective combination of cost efficiency, operating flexibility, balance sheet resiliency, market segment diversification, and strategic agility.

We remain bullish about StandardAero's future growth potential and ability to be opportunistic but like all aerospace companies, we are focused on working our way through the near term uncertainties. In the meantime, all of StandardAero's primary MRO facilities continue to remain open for business today and our

employees are continuing to provide the essential aviation MRO services required by our customers in all of the market segments we serve.

## Derek Zimmerman, President Gulfstream Customer Support



Derek Zimmerman

### WHAT IS THE STATE OF OUR INDUSTRY?

Around the world, Gulfstream's nearly 4,500-person-strong Customer Support network has been ensuring our customers' aircraft are ready for a return to flight operations. We have also been focused on ensuring the health and well-being of our

customers, our employees, and our communities. Our facilities remained open by quickly adopting new health and safety protocols and network loading has been steady as many operators have used this time for planned and scheduled maintenance. We are committed to helping our customers prepare themselves and their aircraft to resume travel as restrictions are lifted.

Gulfstream already operates the most customer-owned service centers in the industry, and we are continuing to invest to support operators. Since August 2019, we have expanded facilities in Appleton, Wisconsin, and Savannah, Georgia; and added a new service center in Van Nuys, California. We plan to open two new service centers later this year in Palm Beach, Florida, and Farnborough, England. Furthermore, we announced in February 2020 that we will build a new service center at Fort Worth Alliance Airport in Texas. That opening is scheduled for the second half of 2021.

As the world emerges from the current crisis, we'll see more businesses and individuals recognize the benefits of business aviation, and with that, an increase in discretionary maintenance, repair and overhaul work. Gulfstream is ready across the network, with all our aircraft service centers in the U. S. and abroad capable of upgrading, modifying, or refreshing aircraft avionics, connectivity, furniture, and upholstery.

Throughout Gulfstream's 60-year history, our service capability has been a major part of who we are. Strong service and support are integral to the aircraft ownership experience. It is part and parcel of Gulfstream's resilience and will continue to strengthen our industry.

## Brian Rohloff, SVP Customer Support Textron Aviation



Brian Rohloff

### WHAT IS YOUR COMPANY DOING TO WEATHER THIS UNPRECEDENTED TIME?

The health and well-being of our customers, our employees and our community is our top priority during this pandemic. We are adhering carefully to social distancing guidelines and are making face masks

for all employees to limit the spread of the virus. We've also partnered with Wichita State University to manufacture plastic face shields, which we're donating to medical providers to be worn alongside critical personal protective equipment (PPE).

In terms of the business, we are drawing upon our extensive experience of overcoming tough industry times, such as the aftermath of 9/11 and the 2008 financial crisis. We are continuing to invest in product development and have adapted our means of communicating with customers by providing options, but we try to keep it as personalized and innovative as possible.

### HOW IS TXTAV'S SERVICE NETWORK SUPPORTING CUSTOMERS DURING THE PANDEMIC?

We are maintaining operations across our facilities and are continuing to provide 24/7 service and parts distribution support. We also introduced financing options for our customers to ensure maximum affordability and flexibility during this challenging time, and have shared guidance on cleaning and caring for aircraft.

Our 1CALL service is fully operational for AOG support across the globe, which is critical to those flying repatriation or special mission flights. 1CALL connects our customers with Mobile Service Units (MSUs) equipped to deliver factory-direct support in the field. That includes service for engines, tires, brakes and more. We have nearly 80 MSUs worldwide, so we can respond to our customers' needs for service or parts quickly and efficiently during this crisis period.

### COULD YOU GIVE SOME EXAMPLES OF HOW YOUR AIRCRAFT ARE BEING USED FOR COVID-19 RELIEF?

Whatever problem our customers face, our product line can help solve it. Our aircraft are used for a wide variety of special missions, including air ambulance, flight inspection and cargo.

For example, one of our customers is the disaster response company Active Deployment Systems. The organization is supplying life support services, such as large tent systems, large

showers and restroom trailers, fuel – anything required to set up a human shelter anywhere in the United States. Currently, the company is supporting hospital and military operations across the whole of the mainland U. S. with shower and laundry trailers, fold and wash laundry – the kind of tasks that are essential, but that people probably don't give much thought to. They are using a Cessna Citation CJ2 jet, which is invaluable for their operations, particularly during this pandemic.

### PLEASE GIVE US YOUR SILVER LININGS AS WELL – WHAT ARE THE POSITIVES THAT HAVE COME OR WILL COME OUT OF THIS UNUSUAL TIME?

I am incredibly proud of how our company has dealt with the crisis so far, and we are doing everything we can to have a positive impact during this time. It's so rewarding to see our products being used to support Covid-19 response and recovery efforts. Our aircraft are being used as air ambulances, for repatriation, and as a means of transporting medical equipment and supplies to hospitals around the country.

The force of this virus will subside, and the economy will recover. When it does, Textron Aviation will be here, persevering like we have for more than nine decades, and ready to serve our customers and communities with pride.

## Philip Anson Jr., CEO STS Aviation Group



Philip Anson, Jr.

### WHAT IS YOUR COMPANY DOING TO WEATHER THIS UNPRECEDENTED TIME?

The safety of our employees is our primary concern right now. Second to that, however, we are focused on costs and cash flow from a business management standpoint.

STS Aviation Group (STS) is a diversified company. Some of our divisions are service focused while others are asset intensive. Many are outside of the United States. Cost management for each division has been a company-by-company exercise. It feels like we have now gone through our annual cost budgeting and revenue forecasting process many times over, and we will continue to do so during these unprecedented times.

Cargo operators and military programs continue to show strong demand. Asia is in the early stages of showing increased demand as their economy begins to come back online.

Managing our customer demand to our costs and cash burn is now our biggest focus for the long term.

## WHAT ARE YOUR PREDICTIONS ABOUT HOW THE AVIATION MAINTENANCE INDUSTRY WILL RECOVER?

We are predicting a slow recovery. Required aircraft maintenance will not be a choice as our customers begin to operate the aircraft more. Many of our airline customers do not have significant internal resources to support much of their aircraft maintenance needs, and they will rely on maintenance suppliers like STS to support them as they begin to fly more. We will be here for them as that happens.

## WHAT IS THE ECONOMIC OUTLOOK FOR THE AVIATION MAINTENANCE SECTOR?

The airline spend will be reduced substantially because of the lower number of aircraft being operated. Prior strong customer relationships will be key to maintenance providers picking up business as the industry begins to come out of this. Airlines with the least amount of internal maintenance resources will be in need of the most help. As in past economic downturns, our customers have turned to companies like STS Aviation Group to help with the initial ramp up before adding significant internal resources. If this happens, as it has in the past, the aviation maintenance sector could see an earlier uptick in demand than the industry as a whole.

## HOW LONG DO YOU PREDICT THE RECOVERY PERIOD WILL BE?

We have always been accused of being an overly optimistic group, but we are also realists. We expect to see a small uptick in demand mid-summer, but no real recovery trends will show until Q4 of 2020. We are hoping to see good recovery trends to start showing Q1 of 2021, but there are still a lot of things still up in the air that will affect that timeline.

## WHAT CAN WE EXPECT FOR THE REST OF 2020; FOR THE NEXT TWO YEARS; FIVE YEARS?

Our crystal ball is not working as well as it has in the past, but we can listen to the industry experts as everyone else is. It looks like we are in for long-term recovery regardless of who you talk to. Each business will have different timing of demand schedules based on their individual customer mix. We have a good mix of cargo operators and mid-sized airlines. We have also had a good focus on the regional carriers and military program support. We serve many international locations and customers that may have earlier recovery curves than what we can expect here in the United States.

## WHAT DO YOU THINK THE LONG-TERM IMPACT OF THE PANDEMIC WILL BE?

We think there will be a lot of organizational restructuring from the carrier side of things. More consolidation of the supplier bases will happen. Supply chain restructuring, organization

efficiency and cost focuses will be the name of the game. As much as we all hate to go through times like this, it often forces organizations to make hard but long overdue decisions that possibly would not have been made otherwise. Decisions that ultimately can allow a business to come away leaner, meaner and more profitable. Those that survive often find themselves in even stronger financial positions in the long term. We found that to be the case after 9/11 for our company.

## PLEASE GIVE US YOUR SILVER LININGS AS WELL – WHAT ARE THE POSITIVES THAT HAVE COME OR WILL COME OUT OF THIS UNUSUAL TIME?

Change is scary, especially when it is as dramatic as what we are now going through now. The negatives are obvious, but the opportunities that will present themselves on the recovery end can be tremendous. Every organization in our industry with the right mindset, a solid plan, and resources to get them through to the recovery phase will have new, and abundant, opportunities to interact with customers that were not present prior to the downturn. Those organizations that are adaptive and innovative should fare well in this “new-world” economy.

## Jonathan Berger, Managing Director Alton Aviation Consultancy



Jonathan Berger

## WHAT SHOULD COMPANIES BE DOING TO WEATHER THIS UNPRECEDENTED TIME?

With a long history of weathering numerous industry shocks, a playbook of cash preservation lessons-learned and best practices has evolved for airline maintenance and engineering divisions to follow. This includes:

- A. Engineering and Maintenance Planning:
  - Defer or cancel all non-essential spend (e.g. planned capital projects and aircraft modifications)
  - Right-size the fleet; in collaboration with the network & fleet planning teams, support development of tail-specific aircraft retirement, storage, and lease return plans
  - Leverage unencumbered assets for liquidity through secured credit vehicles or sale-leasebacks (e.g. spare engines, component inventory, GSE, tooling, etc.)
- B. Airframe Heavy Maintenance:
  - Avoid costly maintenance expenditures by parking or retiring aircraft as they approach their next scheduled major overhaul

#### C. Engine & Component Maintenance:

- Execute 'green-time' programs to avoid costly shop visits (i.e. leverage time remaining on their stored or parked fleet of spare engines, APUs, and landing gears)
- Tap the engine lessor market to defer engine shop visit inductions
- Harvest stored or parked aircraft for aircraft components to reduce spares purchasing and repair activity
- Develop alternate materials strategy (i.e. accelerate adoption of surplus parts/USM, PMA, and DER repairs)

#### D. Line Maintenance:

- Leverage robust third-party Line Maintenance supplier market
- The prudent and rational strategic path forward for MRO executives is to focus on their fundamental core competencies while ensuring the right balance of fixed vs. variable costs in order to be well positioned to rapidly increase capacity as demand returns, and be better prepared to weather the next inevitable downturn.

### WHAT ARE YOUR PREDICTIONS ABOUT HOW THE AVIATION MAINTENANCE INDUSTRY WILL RECOVER?

Very slowly.

### WHAT IS THE ECONOMIC OUTLOOK FOR THE AVIATION MAINTENANCE SECTOR?

Cash is king - those companies that have don't have enough access to cash to get through the next 12-18 months may not survive.

### HOW LONG DO YOU PREDICT THE RECOVERY PERIOD WILL BE?

100% dependent upon when a vaccine is developed. Anywhere from 2-5 years.

### WHAT CAN WE EXPECT FOR THE REST OF 2020; FOR THE NEXT TWO YEARS; FIVE YEARS?

Pain.

### WHAT DO YOU THINK THE LONG TERM IMPACT OF THE PANDEMIC WILL BE?

Similar to how the terrorist attacks of 9/11 spawned a multi-billion dollar aviation security industry, one could assume that the Covid-10 pandemic will undoubtedly launch a multi-billion dollar aviation health industry. With regards to aircraft maintenance, 9/11 led to the requirement to retrofit all aircraft with new secure cockpit doors and cabin video monitoring systems. Perhaps the post-pandemic aircraft will require new seating configurations, cabin air filtration systems, etc.

### PLEASE GIVE US YOUR SILVER LININGS AS WELL – WHAT ARE THE POSITIVES THAT HAVE COME OR WILL COME OUT OF THIS UNUSUAL TIME?

It's hard to believe that just a few short months ago, the major issues keeping MRO executives up at night (e.g. skilled labor shortages, limited hangar capacity, and engine overhaul material shortages) have since vanished virtually overnight because of COVID-19. The flood of used serviceable material (USM) available in the market will help keep those airline survivor's MRO costs low.

### Rich Phillips, Partner Elevate Innovations



Rich Phillips

### WHAT SHOULD COMPANIES DOING TO WEATHER THIS UNPRECEDENTED TIME?

Looking back at the financial crisis of 2008/09 is helpful when viewing a path for companies today. The speed and severity this time is much higher, but the necessity to reform towards strength is the same. Technology

and automation were leveraged at the time to improve efficiency, spread decision-making, and optimize the available assets. In today's world, that defines "Digital Transformation" and the adoption of a data-driven operation. Companies that have invested previously in a strong digital portfolio are more resilient to the pressures placed on the organizations relying on human engagement. Companies have the opportunity to take a step back and look at their portfolio, identify where they are "human heavy" and "digital light" and look to start or accelerate progress in addressing that balance.

### WHAT ARE YOUR PREDICTIONS ABOUT HOW THE AVIATION MAINTENANCE INDUSTRY WILL RECOVER?

The uncertainty around market recovery hides the potential for the maintenance industry. As capacity and forecasts settle, providers will have ideal conditions to partner with their customers and prioritize work. Finance concerns will continue to define timing, but maintenance providers that can better utilize data to determine how to clear work and put back into service should be advantaged. For a service provider to be able to work with the customer and optimize work enables the airline to maximize their reduced fleet for more efficient operations.

## WHAT IS THE ECONOMIC OUTLOOK FOR THE AVIATION MAINTENANCE SECTOR?

Airline fleet management shows that the maintenance sector is an early indicator of recovery for the wider market. Delayed and cancelled new aircraft mean that airlines will seek to invest more into current fleet. Aircraft previously scheduled for exit due to maintenance thresholds are now viewed as more viable. The entirety of an airline's grounded fleet (often more than 70% of the total) will not be fully reactivated during the recovery. The pressure will be on to selectively source and recover individual aircraft which present ideal economic operating models. The maintenance sector is poised to provide partnership to customers through the selection process and enable a path to financial improvement.

## HOW LONG DO YOU PREDICT THE RECOVERY PERIOD WILL BE?

There is not enough data to clearly state the period, but indications point to a 12-18 month window of recovery. During this time the industry will radically adjust fleet size, operations, automation, and resourcing. The fleet composition will change, meaning that many airlines will continue operations with aircraft well past their original end-of-service dates. A full recovery to balanced operations and healthy financials is expected to take at least 2-3 years.

## WHAT CAN WE EXPECT FOR THE REST OF 2020; FOR THE NEXT TWO YEARS; FIVE YEARS?

2020 will see the stabilization of fleets at reduced levels, as airlines continue to work through the individual aircraft for performance. These organizations will also begin rapid transformation towards data-driven operations which could stretch to the end of 2021, however changes will begin to make an impact this year. The additive value of change means that stability reached in the next two-three years should place the airlines and industry as a whole in position to invest and grow. In five years, the industry will look smaller than 2019, but will be more efficient, financially healthy, and designed to survive future shocks better than previously.

## WHAT DO YOU THINK THE LONG TERM IMPACT OF THE PANDEMIC WILL BE?

There is no doubt the pandemic will have lasting effects on the industry. However, the nature of the impact, the speed and level of reduction, and lack of governmental clarity on how they will address social activities in the future, makes it extraordinarily difficult to predict. Aviation is a critical global infrastructure, and demand in cargo, business, and some family travel is the foundation from which the industry will grow. Expected passenger reductions and ongoing travel restrictions will most heavily impact the longer international routes that have been primary growth for many airlines in the last five years. Recovery will likely be a hub/spoke operation, with

business-heavy routes prioritized. The change to the OEM backlogs will be a primary indicator of the long-term impact on the industry. Digitalization will be expected, and customers will begin to observe changes to operations that were not previously supported such as facial recognition boarding, aircraft system improvements, seating configurations and spacing. Passenger costs are likely going to be higher during the recovery, and may not reach 2019 levels for some time. Customer loyalty programs will evolve and be more closely utilized by the operational digital teams as well.

## PLEASE GIVE US YOUR SILVER LININGS AS WELL – WHAT ARE THE POSITIVES THAT HAVE COME OR WILL COME OUT OF THIS UNUSUAL TIME?

The Digital Transformation of aviation will be quite positive and reflect what has happened in other industries to massive benefit. The operational reduction will improve utilization and focus the drive towards dynamic maintenance, improved visibility, and agility. Digital operations will provide the value lever to recover, stabilize, and grow towards the future of air transport. Maintenance is a critical element of this process, and providers are in position to develop closer customer relationships and more predictable workflows.

## Ryan Waguespack, Senior Vice President National Air Transportation Association (NATA)



Ryan Waguespack

## WHAT SHOULD COMPANIES BE DOING TO WEATHER THIS UNPRECEDENTED TIME?

Repair stations are continuing to see activity, as customers are using this down time to complete inspections and upgrades. Their focus should be on maintaining their workforce and

furthering their internal safety initiatives. MROs are finding great success in specializing with certain models and makes.

## WHAT ARE YOUR PREDICTIONS ABOUT HOW THE AVIATION MAINTENANCE INDUSTRY WILL RECOVER?

The maintenance sector will ultimately be affected by this pandemic, but we have yet to see how that ripple will take place. Business aviation is anticipating a boom, as companies look to keep their workforce safe. Private travel is expecting an increase, as the airlines scale back and cut passenger capacity to only a fraction. It will take years for the airline industry



to return to pre-pandemic levels. Until we see how MRO businesses are impacted, we won't know what recovery will look like.

### **WHAT IS THE ECONOMIC OUTLOOK FOR THE AVIATION MAINTENANCE SECTOR?**

As more aircraft enter into service and activity begins to increase, MROs around the country will see more work. If aircraft sales continue to rise, the need for more modifications will also increase, filling those potential future gaps in business.

### **HOW LONG DO YOU PREDICT THE RECOVERY PERIOD WILL BE?**

Flight activity is going to take months to get back to some semblance of normality, we will most likely see a W shaped flight activity recovery period. We will see companies that currently own business aircraft examining all methods of utilizing it to maintain their business prosperity, including expanding use through charters or by their own employees.

### **WHAT CAN WE EXPECT FOR THE REST OF 2020; FOR THE NEXT TWO YEARS; FIVE YEARS?**

For the remainder of 2020, we are cautiously optimistic. The next two-five years are hard to tell, as so many factors play into this.

### **WHAT DO YOU THINK THE LONG TERM IMPACT OF THE PANDEMIC WILL BE?**

It's going to force all businesses to look internally at sustainability. Businesses will look to build more cash reserves and operate with a lean workforce — doing more with less.

### **PLEASE GIVE US YOUR SILVER LININGS AS WELL – WHAT ARE THE POSITIVES THAT HAVE COME OR WILL COME OUT OF THIS UNUSUAL TIME?**

It's been inspiring to see so many of our members from across the industry, especially MROs, innovating to protect the safety of their employees and working to give back to their communities. We are hearing story after story of our members who are diversifying their operations to manufacture and deliver much-needed PPE and other critical supplies and services. Our industry was born out of ingenuity and continuous innovation. This spirit and drive will get our industry through these incredible challenges and beyond.

## **Andy Hakes, CEO AireXpert**



Andy Hakes

We spend a lot of time speaking with mid-level & senior management teams at airlines and based upon what we're seeing and hearing, this is indicative of what we expect to occur as we emerge from these horrible market conditions. Several common themes seem to regurgitate throughout all of our conversations with air carriers across the globe.

The (very) bad news for U.S. carriers is that there appears to be significant cause for concern as the terms of the CARES act expire. While the fallout for folks who work in MRO is obvious, the ripple effects are also going to be problematic for airlines who have to deal with a mass exodus of talent, knowledge and experience.

For U.S. airlines who now have taxpayers as major shareholders, passenger rights regulations could again become a hot topic as they have in Europe and more recently, Canada. Even if this issue doesn't gain traction in the formal sense, expect increased congressional & media scrutiny along with a higher level of attention to service and operational failures.

Several leadership teams have already publicly acknowledged that the post COVID-19 recovery will produce airlines that are smaller and "more efficient". An oft-repeated phrase that we've heard in conversations is that "we have to figure out how to do more with less". While we're in 100% agreement, I personally don't envy the decision makers who have to figure out where to slice and dice when peoples' livelihoods are at stake.

One area of concern that we're focusing on now is the health and continued viability of airline vendor networks. We recently reached out to a very specific yet large cross section of vendors that airlines are heavily reliant on to assess their outlook and positions. The responses ranged from neutral to downright worrisome. A significant percentage of the vendors which supply airlines tend to fall into the category of "mom & pop" operations who haven't yet defined a strategic niche, operate on thin margins and lack access to external capital. The sustained loss of revenue is hugely problematic to the extent that COVID-19 could prove to be an existential crisis for them.

Within that market and where cost pressures are always a significant factor, the margins that these companies live off of often aren't enough to pay for training or senior talent. As a result, turnover tends to be high and airlines have to swallow the bitter pills that often accompany a lack of highly experienced technical talent. At best, the vendor networks will somehow survive the downturn. At worst, the appetite for further cuts and pricing pressures simply may not be there.

To add another layer of complexity, (as if we needed another) several managers privately voiced their frustrations to me, (in effect) saying, "When airlines were handing out performance bonuses and profit sharing checks, we were left out in the cold. Now that shared sacrifice is the message, they're saying 'we're all in this together'." Given that sort of sentiment, airlines may very well have to take some measures to strengthen their vendor partnerships going forward.

Another minefield which might be drastically altered by squeezed budgets is maintenance training. While training makes practical sense, the upfront costs are extensive and the return on that investment is difficult to quantify in a traditional sense. In an environment of extreme cost-saving measures, CFO's and finance directors are likely to take an axe to training budgets which ultimately will have long-term & negative consequences for maintenance operations.

Like many companies, we're hoping for the best and planning for the worst. It's encouraging to see indications of a small uptick in passenger traffic and it's our hope that the revenue folks can entice people back onto the planes. As long as the trend continues, we'll see the operational folks focusing on the many things that will be necessary to ensure that airlines can successfully do "more with less."

## Neil Book, CEO and President JSSI



Neil Book

### WHAT IS THE STATE OF OUR INDUSTRY?

Based on the real-time data available to JSSI, April 2020 flight hours are down approximately 75% compared to April 2019. As a number of countries begin to ease restrictions and borders begin to re-open, we predict a very modest increase in the month of May with regards to flight hours.

Until there is a highly effective treatment or vaccine for COVID-19, we expect to see significant changes to how business jets are being utilized. The largest demographic of business jet owners are males over the age of 60, who fall into a "high risk" group. I've had extensive conversations with a number of clients that fall into this category and while they will continue to fly, they intend to reduce the frequency of their travel, so as to avoid hotels, conferences, etc.

With that said, we are already seeing a significant number of new users migrating to a wide range of business aviation options, such as jet card, charter, fractional and even outright ownership. For many businesses and individuals with the resources, the health risks associated with walking through a commercial airport with thousands of people and getting onto a commercial flight is simply too great.

In JSSI's Q1 Business Aviation Index, we saw the lowest March flight hours since the global financial crash of 2008. April flight hours are the lowest we have on record. While I do believe flight hours will steadily increase from this point forward, it may take several years before we get back to 2018 and 2019 levels.

## Oliver Wyman Updates MRO Forecast Due to Impact of COVID-19

Oliver Wyman has revised and updated their annual MRO Forecast as a result of the impact of the coronavirus and related illness, COVID-19. They have provided **Aviation**



Dave Marcontell

**Maintenance** with that update. The authors of the revised report are Dave Marcontell (shown here) partner in Oliver Wyman's Transportation and Services practice; Tom Cooper, vice president of CAVOK, Oliver Wyman's technical consultancy and services division; Carlos Garcia Martin, principal in Oliver Wyman's Transportation

and Services Practice; and Ian Reagan, senior manager with CAVOK, who leads Oliver Wyman's MRO Market Intelligence group. Their updated forecast and comments follow.

It is difficult to overstate the effect the COVID-19 pandemic is having on commercial aviation. In the months since the new strain of coronavirus that causes COVID-19 first emerged, passenger air travel has come to a near standstill as a result of the need for social distancing and international travel restrictions to contain its rapid spread. Air carriers around the world are facing extreme financial pressures and are cutting capacity at unparalleled rates in the absence of meaningful passenger demand. Some airlines have shut down completely, many to never return.

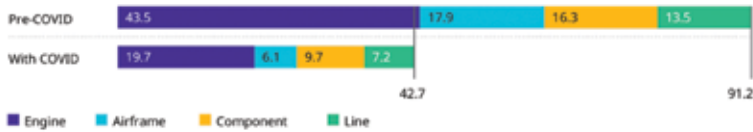
Simultaneously, the global economy is in a tailspin, with unemployment rates at highs not seen since the Great Depression, making the road back for the industry that much harder. From the industry's perspective, there are no real precedents to provide lessons on a clear way forward, including the terrorist attacks on September 11, 2001 or the collapse of business that accompanied the 2008 global financial crisis and subsequent global recession that followed.

One fact is clear: All paths to recovery begin with epidemiology. Until we get a grasp on what lies ahead from COVID-19, we can't expect to rebuild either the economy or aviation on a firm foundation.

### Anticipating the Future

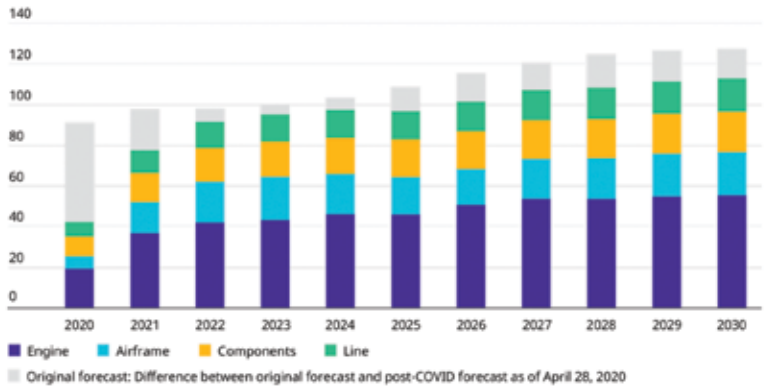
In an effort to get ahead of what's to come for various industries, Oliver Wyman has developed the Pandemic Navigator. The model forecasts the number of new and cumulative coronavirus cases across nearly 40 countries, incorporating the effectiveness of public health containment and suppression measures. We combined its output with forecasts on gross domestic product growth and historical and near-term air travel booking data from the International Air

**Exhibit 3: 2020 MRO spend will drop more than 50 percent from what was expected**  
US\$ billions



Note: With COVID forecast updated as of April 28, 2020. Pre-COVID forecast was published February 11, 2020  
Source: Oliver Wyman analysis

**Exhibit 4: The 10-year forecast on MRO demand by sector**  
2020 to 2030 (US\$ billions)



Source: Oliver Wyman analysis

Transport Association and developed three possible scenarios for passenger demand recovery.

Our baseline forecast for global virus containment represents a more moderate view of what lies ahead for the industry and the one we consider most likely. It assumes multiple waves of contagion. Under this scenario, passenger revenue begins its recovery in late summer 2020 and reaches 60 percent of pre-COVID levels by late autumn when it will plateau as new infection hotspots flair up. Growth remains suppressed until a vaccine is developed, which we expect to happen sometime between spring and summer of 2021 assuming fast-tracking by regulators. Global air travel will finally return to pre-COVID levels by the end of 2021, nearly two years after the initial outbreaks. Regional, domestic and international variations will apply.

To underscore the degree of uncertainty behind any forecast, we have also developed two alternative scenarios. One assumes a single wave of outbreaks, which allows for continuous recovery beginning in late summer 2020. Passenger revenue would steadily climb to 90 percent of pre-COVID levels by early 2021. While the United States and some European countries are still struggling to effectively contain emerging outbreaks, this scenario remains plausible, particularly in specific nations like China where COVID-19 seems to be under control.

The third scenario envisions a prolonged epidemiological response during which there are multiple waves of contagion and delayed vaccine development. It also assumes an extended global economic recession. In this most pessimistic scenario, the virus is not contained until early 2021. The recovery is much more gradual, not reaching pre-COVID levels until 2023.

In the case of the ongoing COVID-19 pandemic, the contraction of the global commercial in-service fleet is already

more pronounced than in any of the prior crises: As of late April, over 65 percent of the pre-COVID fleet of 27,500 commercial aircraft have been parked, with many never to return to service. Previous shocks to aviation have also led to early aircraft retirements, and COVID-19 will be no different. While for the last five years annual retirements have ranged from 550 to 750 planes, we expect to see a surge to well over 2,600 during the next 12 months.

As previously described, the pace of fleet recovery is expected to require several years. Our baseline scenario does not expect the fleet to return to its pre-COVID size until the end of 2022.


### Impact to MRO Demand

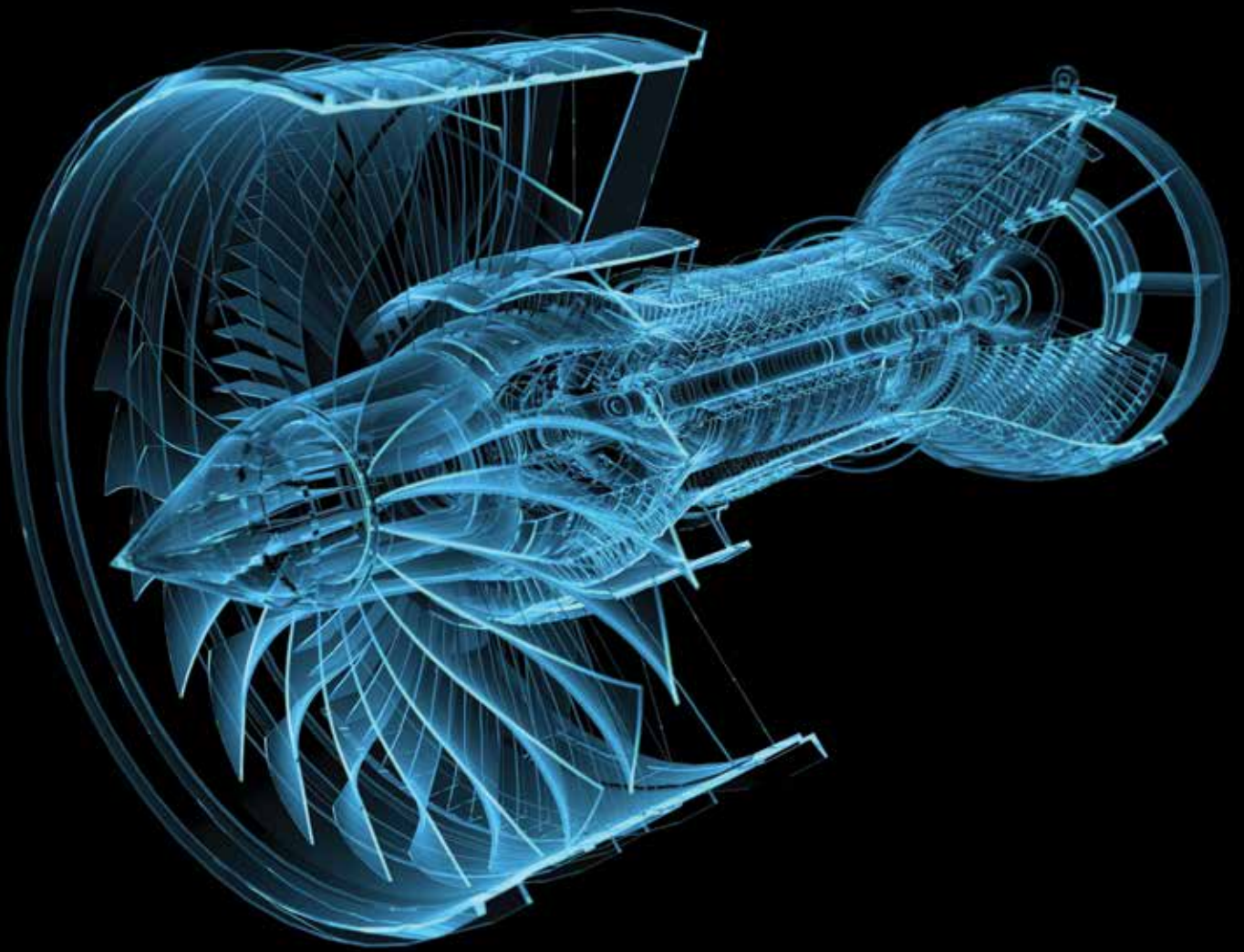
Assuming our baseline scenario that anticipates recovery starting later this summer, the current trajectory for fleet reductions and lower aircraft utilization would reduce global demand for maintenance, repair, and overhaul (MRO) in 2020 by more than \$48 billion, or 53 percent, from our original pre-COVID forecast of \$91.2 billion. All regions of the world will experience declines of 40 percent or more.

As a result of this unprecedented crisis, airlines have focused on cash management and survival. For many, that will translate into far lower demand for MRO services and months, if not years, of stripping parts from parked or retired airplanes. This cannibalization will create a substantial ripple effect throughout aviation's supply chain and will make it critical for MRO providers to consider supplier survival, as well as their own cash flow management. MRO response tactics need to focus on supply chain fixed costs during the crisis and preparation for a long recovery period.

For airlines, especially those receiving governmental support in the near term, it will mean restructuring to accommodate extended, depressed demand. Executives should be considering zero-cost budgeting, contract renegotiating, and the right-sizing of operations to create a more flexible and variable cost structure. In addition, airlines and MROs alike will need to consider how to maintain the existing talent in the market, so whenever the industry finally begins to get back on its feet the necessary experienced personnel are there to support renewed growth.

The MRO industry is comprised of an incredibly diverse set of companies. The largest providers have evolved through years of growth and consolidation. COVID-19 will represent another challenge in their evolution, likely the most significant in their history. However, the smaller MRO providers, which are much more numerous, may face an existential threat to their business. In less than three months, the COVID-19 pandemic has wiped out a substantial portion of industry value, both for shareholders and on balance sheets. This will take years to rebuild, but those who have reacted quickly to preserve cash and manage their underlying cost structures will be in a stronger position to capitalize on new and emerging opportunities, which history has shown will inevitably appear.

— **Courtesy of Oliver Wyman** 



# TWINNING

## DIGITAL TWINS SHOW THEIR POWER

Louise Bonnar



The current focus on digital twin technology lies in enabling preventative and predictive maintenance for airlines and MROs, in a effort to increase reliability and safety for the operator. Lufthansa Technik image.

**T**he potential of digital twins for aerospace is coming to light. Digital twins, virtual simulations of physical assets, are finding their way into aerospace. Original equipment manufacturers (OEMs) can design new engines, airframes or complex components or test how assets will mature throughout lifecycles. These virtual models allow OEMs to refine maintenance contracts and aftercare processes; it can make the twin undergo stress tests that may not be logistically possible inside a laboratory; or it can test out new designs or re-designs to establish whether to begin manufacture for physical tests. Today, entire, complex digital twins of engines are in use by OEMs.

How far can this technology extend into the industry and is there a use case for non-OEMs to use them as well? "OEMs are leading

the innovation, in particular engine manufacturers," advises Nadine Etong, director, MRO Product Line at the Aerospace and Defense Business Unit, IFS. For instance, an OEM can use a virtual copy of an in-service engine to model operational scenarios that improve future designs. "Digital Twins can help us build up knowledge on how parts behave in service, which can then be used to help us be more intuitive when we design new parts," adds Dr. Chris Heason, engineering specialist – Civil Aerospace at Rolls-Royce.

Rolls-Royce has pioneered the implementation of digital "twinning" within certain stages of manufacture and maintenance, with a designated Intelligent Engine program underway that designs, tests and manages its family of large aero engines digitally. By adding real operational data to a simulation, supplied by customers worldwide via the physical engines, Rolls-Royce can build a picture of the long-term life of its assets. This enhances maintenance programs and

enables predictive and preventative maintenance to prolong time on wing. The aftermarket potential is significant. "Digital twins help us plan aftermarket to maximize fleet availability, minimize disruption, and optimize MRO capacity and throughput," says Heason.

General Electric (GE) is using digital twins in its manufacturing process. "GE has already built digital twin components for its GE60 engine family and also helped develop the world's first digital twin for an airplane's landing gear," says Etong. "Sensors placed on typical landing gear failure points, such as hydraulic pressure and brake temperature, provide real-time data to help predict early malfunctions or diagnose the remaining lifecycle of the landing gear."

Etong adds that GE Aviation also creates digital replicas for its engines, giving the company an electronic trail for every single one. "This allows GE to monitor its performance, predict



AVIATAR is the first step into digital twins for Lufthansa Technik. It is a digital platform with numerous solutions focusing on condition monitoring, predictive maintenance and fault analytics. Lufthansa Technik image.

maintenance issues and, ultimately, reduce costs after the engine leaves the plant," she says.

### Maintenance Applications

Digital twins reap tangible benefits for OEMs. But can areas of the maintenance, repair and overhaul (MRO) industry can benefit from digital twins? "In MRO, we are right at the start of adoption," explains Adrian Jennings, chief product advocate at Ubisense. "Digital twins of many kinds are becoming widely adopted in the manufacturing process, and that experience and technology is being fed into MRO.

"The initial focus within MRO tends to be on asset management, for instance tooling and ground support equipment," continues Jennings. "Applications quickly grow into more process-oriented value than asset management. For example, intelligent pre-staging of tools and materials, automatic tool check in, check out, task error proofing, or automatic compliance monitoring."

The current focus on digital twin technology lies in enabling preventative and predictive maintenance for airlines and MROs, which increases reliability and safety

for the operator.

"The commercial aviation industry is going through major disruptions and companies, including MROs, are changing their business models to capitalize on new technologies," says Etong. "Not just digital twins but also artificial intelligence (AI), the internet of things (IoT) and more. The initial focus is on engines, closely followed by components."

MRO provider Lufthansa Technik (LHT) also designs and manufactures engine components in addition to developing repair processes. It therefore has the unique position of speaking from the viewpoint of operator, manufacturer and both airline and third-party MRO provider. "Digital twins are used very often to model design, certification, production and support of modifications, processes or even complete VIP Cabins," adds Peter Isendahl, senior manager at LHT. "Sometimes even our advanced repair processes require a digital model of aircraft components to allow us to use it for automated MRO processes."

### AVIATAR

The first step into digital twins for LHT is AVIATAR, launched in 2017. A

digital platform with numerous solutions focusing on condition monitoring, predictive maintenance and fault analytics, the overall goal for LHT is to create, for an airline, a complete replica of each aircraft in its fleet. For instance, engine health-related data (EHM) is fed through digital twins to help predict when a certain component will fail and will advise the user on AVIATAR.

"AVIATAR will allow airlines to benefit using digital solutions," adds Isendahl. "Meanwhile, there are many other digital twin data models operational within the Lufthansa Group focusing on other areas of operation and hardware for aircraft, since Lufthansa Technik is also a production organisation."

A digital twin requires data, however. Digital twins are currently developed by OEMs, and filtered down to operators or companies within the OEM network. To develop an accurate replica of a complex asset or component, the business building

the CAD file will require access to intellectual property (IP), such as maintenance manuals and complex performance data parameters to reflect accurately. "There is a debate...about data ownership," adds Etong. "OEMs need the data from many airlines. From an airline perspective, they are reluctant to be charged for additional services based on their own data even though they see the value they can get from a consolidated viewpoint. There must be an agreement between OEMs and their customers," says Etong. Ultimately the IP belongs to the OEM.

"Digital Twins are taking off on the airline side, but it is slower with a focus on major sub-systems rather than the complete aircraft," continues Etong. "MROs who have long-term agreements with VIP customers will collaborate with them as they do not have complete visibility on all aircraft operating condition data."

## Other Applications

Digital twins were originally introduced in production processes, to assist in developing, testing and monitoring new technologies. Currently, LHT is deploying digital twins in the design of aircraft cabins. "SkyRetreat" is a A220 VIP aircraft cabin concept developed by LHT, whereby digital designs were used in the initial design phase.

Digital twins are emerging in other areas, aside from engine OEMs and MROs. IFS and TEST-FUCHS have been working on a proof-of-concept together for the last year. Austrian-based manufacturing company TEST-FUCHS has implemented digital twins for the ground support assets and test equipment it manufactures. The project also addresses the potential for digital twins to be developed for pre "new-gen" components, which don't always have sensors fitted.

An important conduit for the digital twin is sensor technology. Emerging

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Not available in USA



IFS and TEST-FUCHS are exploring new areas for implementing digital twins by using test equipment to gather data like resistance and impedance on parts such as hydraulic valves. IFS/TEST-FUCHS image.

## Engine and Airframe Aftermarket

The potential for digital twins to make an impact is in the engine and airframe aftermarket is big. IFS says that use cases are now out there. "Maintenance businesses are now using digital twin technology to focus on preventative maintenance," says Etong. "There is now also a shift towards predictive maintenance. OEMs who are offering care programs, such as power-by-the-hour programs for engine MRO, need a lot of data, from various sources (airlines, MROs, lessors) to be able to generate trends. The intelligence behind this huge amount of data also helps inform the design of new assets, components and even whole engines."

Digital twins are useful for a number of reasons in the aftermarket, elaborates Rolls-Royce's Heason. "Within Rolls-Royce, our Services Digital Twins are virtual models of fleets of engines in in-service life. They combine utilisation, maintenance, route, environment, and performance data to understand future operational and maintenance demands. This helps Rolls-Royce to plan its aftermarket businesses which maximizes fleet availability, minimizes disruption, and optimizes MRO capacity."

Digital twins also enable Rolls-Royce to carry out access simulations for new tools or repair processes that it wishes to implement. There are also less obvious benefits to the use. "Parts may move slightly in service and we may wish to see if our existing tools can still access the part," explains Heason.

"In our blisk repair lab, we also deploy digital twin technology, as it enables us to drive automated repair processes by helping to create the necessary machine movement tool paths for material subtraction and addition," says Heason. "As every part that needs repair is slightly different in geometry due to the operating regime the engine sees we need our repairs to adapt to these differences. As such creating a digital

assets all tend to have sensors, allowing for ease of data gathering. This is the channel providing most of the performance and health monitoring data to a CAD developed twin.

"We have found that it is possible to gather data on older assets, depending on the type of asset. IFS and TEST-FUCHS chose a hydraulic valve used on the Ariane 5 shuttle as part of its investigations into this area," says IFS's Etong. "The valve itself does not deliver data. However, the test equipment used to gather some measurements (such as resistance and impedance) delivers data about the valve. We were therefore able to gather the data we needed through the test equipment, but there are many different possible scenarios. Economically it is more viable if the company does not need to invest in additional tooling, material or software to upgrade existing equipment. Otherwise it is probably not viable, and a company should prioritize newer assets instead."

The idea for TEST-FUCHS was to collect test results from some of their devices and test benches in the field. "These tests results are used for preventive maintenance but could be used as well for predictive maintenance," continues Etong. "The digital twin of the component via IFS Applications can then be used for simulations, what-if scenarios and design improvements."



twin for each part we need to repair enables us to successfully implement this automated and adaptive repair.”

Heason explains that creating a digital twin also allows for better inspection of parts, enabling Rolls-Royce to assess changes to the part through its lifecycle and scheduled overhauls. They are actively deploying digital simulations to enhance repair techniques and processes. “For maintenance, there will be digital twins created for blisk repair for the Trent 1000, Trent 7000, and Trent XWB, ultimately the large aero engines,” explains Heason. “As engines start to employ more complex materials and components, more automated solutions are required and because of the adaptive requirement we have for these repairs, it is likely we will see greater uptake of this digital twin approach for future repairs.”

## Considerations

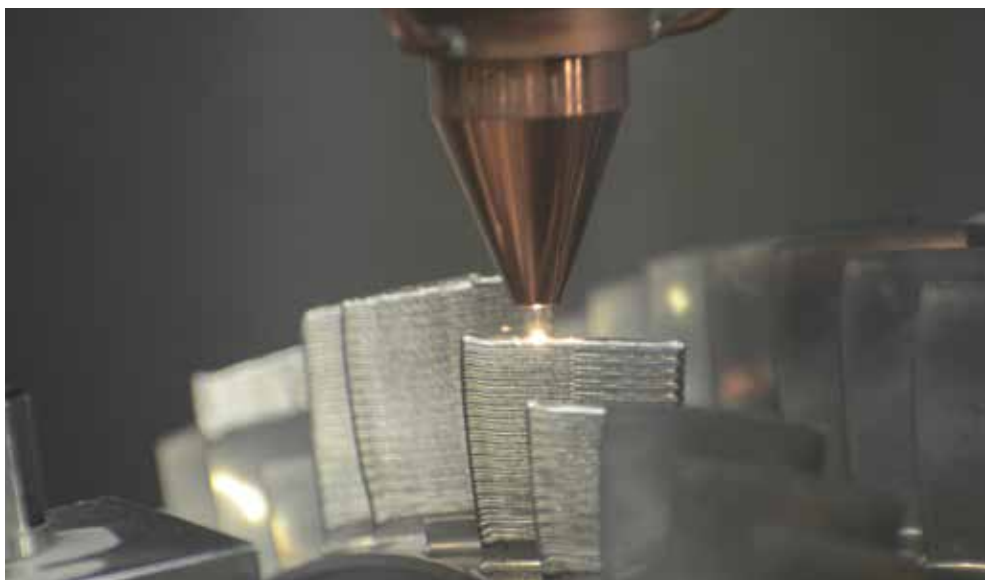
Digital twin technology can extend the overall life of a new-gen aircraft, but can this be transferred to aging aircraft still in operation? MRO providers hope to leverage this technology without the association of a large airline motivating business processes.

“For any component or subsystem in an aircraft digital twins of physical shape could be developed using reverse engineering and processes could be re-modeled, but this can be a lengthy process which would require a solid business case,” says Isendahl. “If required and economically sensible, it is possible.”

This capability would not extend to all MRO providers, however. “Because independent MRO providers, outside of an OEM network neither own the asset or the configuration data, it is extremely difficult to gather the data required to run a digital twin,” highlights Etong. “An operator can provide the independent MRO access to their internet of things (IoT) solution if they have one. This will allow planners to have a better understanding of the aircraft condition...prior to aircraft arrival. The independent MRO can then feed such a solution with detailed information about the aircraft maintenance.”

The focus of the use of digital twins is on aircraft systems that benefit most from the concept. Complex components that cause the most disruption if faults are detected will be a priority for those leveraging the technology. “Airlines will typically focus on some key sub-systems such as engines, landing gear, hydraulic systems and avionics systems,” says Etong. For operators to use digital twins to progress preventative and predictive maintenance, the feeding of aircraft and engine health monitoring (AHM & EHM) into the twin is vital. “‘Day-to-day’ monitoring is done from day one and does not require historical data,” continues Etong. “AHM is one of the main sources of information. To plan for heavy maintenance however, such as a C-check, there is a need to collect months of historical data.”

Engine OEMs will utilize historical data in order to ensure the digital twin models developed in its testing facility are as representative of the physical twins as possible. “The amount required depends on the complexity of the system to be modelled and the accuracy required



Rolls-Royce deploys digital twins to automate repair processes. By developing simulations of each part, the OEM can adapt repairs to suit minute differences in geometry. Rolls-Royce image.

for the solution,” advises Heason. “As the quantity of data increases and the computing power to process becomes available, expectations of modeling accuracy also increase, and we will need to evolve the twins to suit.

“Within our blisk repair project we are creating a digital twin of a very complex component and only have conventional contact measurement



*The aftermarket potential of digital twins is significant. Digital twins can help organizations plan allowing them to maximize fleet availability, minimize disruption, and optimize MRO capacity and throughput.*

data to compare back to the original manufactured part,” continues Heason. “Going forward, there will be a greater uptake of creating digital twins at manufacture, so we can access more data on how the part has dimensionally moved between initial build and overhauls.”

### High-Tech Repair Processes

As the engines and components that power new-gen aircraft have grown in sophistication, so have the processes developed to repair and prolong the life of the asset. These so-called “hi-tech” repairs require significant knowledge of the asset’s design and development in addition to access to intellectual property (IP) and expensive tooling. A digital twin of the asset therefore assists repair shops and providers in developing and testing repair processes on the virtual asset before progressing into physical repair testing saving time and money.

“With data collected, data scientists and engineers can run simulations and determine corrective actions in advance of any defect or damage,” says Etong. “Note that there are already repair instructions provided by the aircraft manufacturer through SRM documents—however, an airline can push the envelope further and

simulate more precise environments based on their operating conditions.

“Take the example of an airline which might be operating in a city where the fog level is higher than normal. Such an airline might want to gather some sub-system measurements under these weather conditions and overlay the data collected, with defects raised by technicians on the ground after the aircraft has landed and inspections have been performed.”

From the manufacturer’s perspective, Rolls-Royce’s Heason explains that a greater uptake of digital twin techniques through design, manufacture and service will enable OEMs to better predict what the input condition of the component will be when it reaches overhaul and aid the early phases of its repair development programmes. “Ultimately this will help us to develop and enhance techniques for hi-tech repair,” he adds.

Will there be a day when each engine and airframe within an airline has its own digital twin associated to it? “There is no reason why a nominal digital twin of an ‘ideal’ engine couldn’t be provided for each engine type given that CAD files exist for the parts, but for ‘real’ digital twin

implementation is more challenging,” explains Heason. “The sheer number of individual components and the complexity of the technology required to create individual digital twins for every component mean that currently, it is sensible to identify key components for which having a digital twin is most useful.”

“In the next few years and decades all new-gen aircraft, engines and components will be available as digital twins,” adds Isendahl. “But more important are digital twins related to the aircraft operations. It is nice to know how an aircraft was delivered to an airline, but this is just a one-day snapshot. It’s the following 20 to 30 years when the operators have to maintain and modify the aircraft in order to comply with passenger and authority expectations.”

### Digital Process Twins

The reliabilities generated by digital twins can extend to reliability across an entire business. “Increasingly, businesses are employing software systems to help plan and manage complex processes,” says Jennings of Ubisense. “Aircraft MRO is a series of complex processes. While planning systems have become more sophisticated, virtually replicating a shopfloor to forecast operations is the next step.”

LHT’s Isendahl sees the potential of digital process twins – particularly within logistics. “It happens already in other industries and LHT is making strides into this area,” he says. LHT’s Digital Warehouse is an example. By digitising and automating many of the processes that occur within its warehouse, LHT is able to develop a digital image of the day-to-day movements and therefore a digital representation of the warehouse. Examples of automated processes include wearable scanners that read RFID tags. By adopting these processes within the physical warehouse, LHT is able to build a real-time virtual image of inventory movements that arrive/depart the building.

“MROs can leverage digital twin

technology to streamline their supply chain network,” adds Etong. “Running a digital twin for an asset is only the first step, the aim is to extrapolate this to create a digital twin of a whole fleet of assets. Take this a step further and a digital twin of the fleet can become part of a digital twin of an entire business, with process flows visualized and bottlenecks flagged in real-time—much more valuable than one single model.”

Digital twins could enhance logistics and forecast potential incidents that will cause delays. “MRO operations are a mix of routine and non-routine tasks, where the total work is unknown before the process commences,” adds Jennings. “A plan will need to be updated the moment a non-routine issue surfaces for instance. Even without the non-routine tasks, routine inspections

encounter delays.

“Software planning systems therefore need to understand what’s happening on the hangar floor: they need to be able to monitor what’s going on so they can answer not ‘what is the next step in the plan?’ but ‘what’s the next step that will allow us to remain on schedule even though we’ve veered off plan?’”

What the planning systems need is a view of exactly what has happened and is currently happening on the hangar floor. Jennings explains that it needs to know the real-time status and interactions of people, tools, materials and tasks so the MRO knows exactly where it is in the process and can define next steps. This is the Digital Process Twin. “With that visibility planning systems can constantly adjust and correct for issues as they arise, not



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blindly following the original plan but constantly updating it to maintain efficiency," he says. This is where the true potential of digital twins come into play.

Extending the digital twin to an organization level is certainly possible, agrees Heason of Rolls-Royce. "Digital twin techniques are extremely adaptive. While for us the digital twin is part of a comprehensive suite of digital models, in addition to being designed, tested and maintained in the digital twin environment, our aero engines will become increasingly connected. This means the physical asset and services provided can become further aligned."

### Ubisense Smartspace

Much of the information already exists to simulate processes on an MRO's shopfloor. "Tool databases already include information about maintenance and calibration state and plans already allocate tools to tasks," says Jennings. "The additional questions to answer include: where exactly are those tools? Are they being used by a qualified technician? Are they being used in the right task? Is that task running late jeopardizing the next task that needs the tool? Can we expedite tool transfer from one task to the next, bypassing the tool store?"

"So the additional information required is the physical location of all the relevant assets, and that comes from a variety of different RFID technologies ranging from passive RFID to Bluetooth low energy and ultra-wideband," continues Jennings. "The overall goal is to add the context of location, flow and interaction to existing business data in order to stitch the whole hangar floor picture together into a digital twin."

In terms of installation time, a single workstation could be up and running within a few weeks, and a large facility within a few months. According to Jennings, the biggest effort is the physical installation of sensors, which is done so as not to interfere with hangar operations. Once installed, sensors go through a one-time commissioning process and are then

connected with the software platform operating the digital twin.

SmartSpace takes the raw data from sensors and synthesizes that with other existing data. Its engine models the expected process flow and alerts planning systems the moment an issue arises. The goal is always to detect and correct errors, and to minimize turnaround time by maintaining efficient, coordinated process flow across the entire hangar, says Ubisense.

For the physical twin, sensors are installed up high in the hangar infrastructure, normally looking downward and inward into the workstations. A network of sensors covers the entire hangar floor or areas of critical interest. "Once installed, sensors are unobtrusive and require little to no maintenance," Jennings says.

Assets to be incorporated in the digital twin would then require an RFID tag to be fitted, which is typically a battery-operated active tag with a lifetime spanning several years.

### Future of the Digital Twin

"AVIATAR has been live for over two years, but we were already using process modelling and 3-D design for many years before that date," Isendahl says. "The advantages today are the new digital technologies, computing power and cloud-based solutions. This allows us to introduce more efficient digital solutions quicker, yet compared to aircraft life cycles of more than 30 years, these are the "early days" for digital twins and digital cooperation."

"The global digital twin market size is expected to reach \$26.07 billion by 2025—registering a strong CAGR of 38.2% over the forecast years," says Etong, "and we are now starting to see the first successful use cases of digital twins in action in commercial aviation, but there is more to come." As the potential for digital twins expands across the industry, non-OEMs can explore the benefits for their business and assets. By utilising platforms developed by software providers that can perform the data mining and simulation required to develop a twin, the concept will continue to flourish. 

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# MAINTENANCE IS A TEAM SPORT

Jeff Guzzetti



Former NTSB and FAA investigator Jeff Guzzetti provides a tragic case study of a fatal corporate aviation accident prompted by organizational deficiencies and ineffective communications between maintenance technicians, managers and pilots.

Jeff Guzzetti is the president of Guzzetti Aviation Risk Discovery (GuARD), an aviation safety consulting firm that he formed following a 35-year career with the National Transportation Safety Board (NTSB), Federal Aviation Administration (FAA) and other agencies. During his 18 years at NTSB, Guzzetti was a field investigator, “go-team” engineer and Deputy Director. He then served as an Assistant Inspector General at the Dept. of Transportation and testified before Congress regarding aviation safety audits. In 2014, Guzzetti served as the Director of FAA’s Accident Investigation Division in Washington, DC until his retirement in 2019. He is a graduate of Embry-Riddle Aeronautical University with a degree in Aeronautical Engineering and holds a commercial pilot certificate with multi-engine instrument ratings in airplanes, seaplanes and gliders.



The eyewitnesses were enjoying a beautiful Tuesday morning in an upscale subdivision in Sanford, Florida when they noticed a low-flying twin-engine airplane zoom past them. The Cessna model 310R banked sharply to the left before clipping a palm tree, grazing the corner of a home, and tumbling into two more homes before exploding into flames (see graphic next page, lower right).

The date was July 10, 2007. As emergency crews responded to the massive fire in Sanford, I was just arriving at NTSB Headquarters in Washington, D. C. to begin another day as the deputy director for Regional Operations. Meanwhile, veteran investigator Brian Rayner was working off his backlog of general aviation (GA) accident reports

at the NTSB’s Eastern Regional Office near Dulles Airport in Northern Virginia. Rayner, with a dozen years of NTSB accident investigation experience along with Army helicopter combat time, was the on-call investigator for the next “launch” if a fatal accident were to occur east of the Mississippi. Sure enough, his phone rang: “We’ve got a Cessna 310 in a house near Orlando,” the NTSB duty officer said. Rayner quickly booked a commercial flight out of Dulles Airport to Orlando for a typical “one-person go-team” launch on what seemed to be another typical GA accident.

But as more information came in, and as thunderstorms closed in on Dulles Airport, plans had changed. Rayner soon realized that he would be assisted by a full go-team whether he liked it or not. He learned that the airplane was registered to the National Association for Stock Car Auto Racing (NASCAR)



The accident airplane: A twin-engine Cessna 310R, manufactured in 1977. (NTSB Photo)



Aerial photograph showing the main wreckage and impacted homes. The blue arrows show the general westerly direction of the airplane's travel at impact. The aircraft struck the palm tree shown in the upper left-hand corner of this photograph. (NTSB Photo)

aviation division (see graphic upper right). Michael Klemm, NASCAR's most senior pilot with 10,000 flight hours, and Dr. Bruce Kennedy, the organization's chief medical officer and also a commercial pilot, were killed in the crash. Dr. Kennedy was also the husband of Lesa France Kennedy, the president of the Daytona Speedway and the granddaughter of Bill France Sr. who founded NASCAR in 1947. Three more people were killed on the ground — a mother and her six-month-old son in one house and a four-year-old girl next door. Two other people and their 10-year-old son were seriously burned but survived.

It was decided that Rayner would lead a go-team on this accident, with newly minted NTSB Board Member Robert Sumwalt as its spokesperson. Sumwalt is now the chairman of the NTSB. A former airline captain and corporate aviation manager, Sumwalt

was no stranger to aviation safety. But this day would be his first experience as a go-team spokesperson, with Brian Rayner "training" him like so many other board members before. Rayner had my full confidence — he had recently been promoted as a senior air safety investigator and successfully completed a previous investigation of a King Air missed-approach accident that killed 10 people associated with the Hendricks Motorsports NASCAR racing team.

### An In-Flight Fire

Sumwalt and the other go-team members were to be flown on an FAA jet from Washington's National Airport to Sanford, Florida. Rayner was already boarding a commercial flight from National because his Dulles flight had been cancelled due to storms. He was pulled off his flight by airport officials and whisked to the FAA jet to join his go-team. During the flight, Rayner



NTSB Vice Chairman Robert Sumwalt (left) surveys the accident site with air safety investigator Mike Huhn, who led the Maintenance Records Group. (NTSB Photo)

surveyed the accident site (see top graphic above). Although much of the airplane was destroyed during the postimpact fire, investigators observed soot deposits on airplane parts that were found separate from the main wreckage and thus were not directly exposed to the post-crash fire. The instrument panel deck skin, glare shield and cabin door displayed thermal damage and bubbled paint, consistent with an in-flight fire. Rayner also met with the three FAA inspectors from the local Orlando office who were first to arrive at the scene. He thanked them for quickly picking up all of the pieces of paper that were blowing around the site right after the fiery crash. Fortunately, one of those pages was a maintenance discrepancy sheet dated the day before the accident that described a “smell of electrical components burning.” (see graphic, lower left). Rayner was stunned to see that there was no indication of corrective action for this discrepancy under the right half of the sheet entitled “Maintenance Clearing Action.”

The NTSB identified and interviewed the NASCAR company pilot who flew the accident airplane the previous day. He said he was returning from North Carolina when the weather radar unit went blank and he smelled smoke that was “strong enough where I would have diverted if it had continued.” He said he pulled the circuit breaker that controlled the radar and the smoke went away. After landing, the company pilot complied with all of NASCAR’s established procedures for reporting the airplane discrepancy. He wrote up the problem in the plane’s flight log and filled out a maintenance form. He left the white original in its binder in the airplane, verbally informed the NASCAR maintenance technician of a radar problem and handed the yellow copy of the discrepancy writeup to the director of maintenance (DOM).

### Who is In Charge?

The investigation revealed that the

This critical document, a maintenance discrepancy sheet dated the day before the accident, was fortunately recovered at the accident site by fast-acting FAA inspectors from the local Orlando Flight Standards District Office. Note that the “clearing section” on the right side of the form is blank. (NTSB Photo)

briefed Sumwalt that the NASCAR Cessna 310R accident occurred during a “personal flight” from Daytona Beach with an intended destination of Lakeland, Florida. Ten minutes after departure at their cruise altitude of 6,000 feet, the pilots declared an emergency because of “smoke in the cockpit” and asked to divert to Sanford. The last radio transmission was received less than a minute later and was terminated midsentence with the phrase, “shutoff all radios, elec ...”

Upon arrival, Rayner and Sumwalt



discrepancy was briefly discussed in the chief pilot's office with the DOM and company pilot present; however, neither the DOM or chief pilot took any actions to ensure that the airplane was inspected, modified or grounded. Instead they agreed that — even though it had an unresolved discrepancy — the airplane would remain available for the personal flight the next morning. The Chief Pilot telephoned Michael Klemm (the accident pilot) to say that the DOM told him that the Cessna 310R would “be okay,” and that Klemm should not turn the radar on.

The NASCAR mechanic who was primarily responsible for the airplane told investigators that although he did conduct certain tasks to prepare the airplane for flight, he did not examine the discrepancy binder or the radar system problem. He said he tried to confirm that Klemm was aware of the problem but it was dismissed as unimportant. Both pilots accepted the airplane “as is” with a known, unresolved discrepancy. The NTSB would later assert that without examining the weather radar system, and then either removing the airplane from service or placarding the airplane and collaring the circuit breaker, as well as making a maintenance records entry, it was not permissible to fly the airplane under Federal regulations.

Rayner and his team also discovered that NASCAR Aviation's maintenance discrepancy forms were not serialized, tracked or retained; instead they resided temporarily in the airplanes and in the DOM's office and were disposed of at irregular intervals. In fact, even though the company pilot handed the yellow copy of the radar discrepancy writeup to the DOM, the DOM was not able to provide it to investigators. Furthermore, NASCAR did not have any formalized means to track the dispatch availability of its airplanes. As a result, the availability of any particular airplane — from an airworthiness standpoint — was neither clearly defined or readily available to anyone. It became

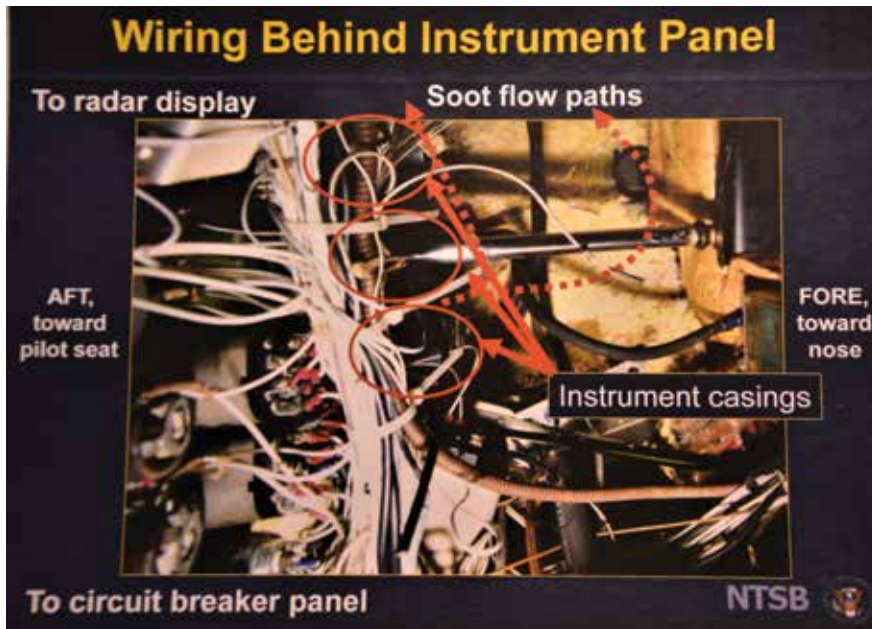


This photo shows the instrument panel of an exemplar Cessna 310R that had a similar configuration as the accident airplane. The location of the radar display and circuit breaker are shown. The dashed line portrays how the wiring was routed between the two. (NTSB Photo)

clear that the day-to-day practices of NASCAR's Aviation division deviated from those specified in their SOP, thus depriving them of a systematic approach to ensure that all maintenance discrepancies would be addressed.

While the NTSB could not conclusively determine the origin of the in-flight fire, the evidence suggested that one of the pilots likely reset the radar circuit breaker which would have been consistent with the “Before Starting Engines” checklist. This action would have restored electrical power to the weather radar system's wiring and resulted in the in-flight fire.

Investigators also examined an exemplar Cessna 310R to aide them in analyzing the soot patterns and determining possible burning scenarios (see graphics above and on following page). A view behind the instrument panel of the similar airplane showed an installation of different types of wire, the different ways that the wires were fastened and how the wiring of different systems can be tied tightly together. Rayner could see how a problem in the wires of one system can affect the wiring of another system or even damage wiring that is upstream of protection that is offered by the circuit breakers. The NTSB also found that



This photo depicts the wiring that was installed behind the instrument panel of an exemplar Cessna 310R. The photo aided investigators with analyzing the soot patterns and determining possible burning scenarios. The photo illustrates the different types of wire, the different ways that the wires are fastened, and how the wiring of different systems may be tied tightly together. The ovals indicate some of the hidden parts of instruments that would be on the left instrument panel. (NTSB Photo)

existing guidance in manuals provided by GA airplane manufacturers regarding the resetting of circuit breakers often does not consider the cumulative nature of wiring damage and that the removal of power only temporarily stops the progression of such damage.

### The Probable Cause and Lessons Learned

As per protocol, I sat next to Rayner at the final NTSB public board meeting in Washington, D. C. to help present the findings of the investigation to Sumwalt and the other four Board Members. Rayner did not disappoint. He and his team — including NTSB maintenance expert Mike Huhn and electrical systems expert Bob Swaim — presented a concise and impactful story about what had led to the tragic accident that took the lives of five people including two children, widowed the granddaughter of the man who founded NASCAR and severely burned a 10-year-old boy (now age 23).

"No action was taken to make sure the aircraft was inspected or grounded," Rayner told the safety board. "When everyone seems to be in charge, then no one is really in charge."

I was quoted by a newspaper asserting

that "This accident started the day before the crash actually happened."

For his part, Sumwalt said, "I think it comes down to a lack of leadership. Flight-department management could have prevented this. You're supposed to be running a professional flight department, not a flying club." Sumwalt had understood early on the importance of a robust safety management system (SMS) in an aviation operation which would have provided NASCAR with a formal system of risk management and internal oversight. He convinced his fellow board members that had an SMS been in place the accident might have been avoided.

But Rayner and Sumwalt also acknowledged that the NASCAR Aviation had quickly learned and applied the lessons from the accident. Well before the investigation was concluded, and through discussions with Rayner and his team, NASCAR made several substantive changes to their aviation operations including: expanded airplane grounding authority, improved maintenance reporting and tracking methods; revised discrepancy forms, new communications procedures, installation of airplane status boards, revised SOPs, the establishment of an SMS program, and the successful completion of an outside independent audit in compliance with the International Standard for Business Aircraft Operations (IS-BAO).

At the end of the board meeting, the NTSB voted to adopt the probable causes of the accident, which were "the actions and decisions by NASCAR's corporate aviation division's management and maintenance personnel to allow the accident airplane to be released for flight with a known and unresolved discrepancy." The NTSB also cited the improper decision by both pilots to operate the airplane with a "known discrepancy...that likely resulted in an in-flight fire."

The board also adopted five recommendations related to training and information about circuit breakers and the importance of implementing Safety Management Systems to prevent accidents. **AM**

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## Human Factors Training: Why The Stigma?

I have been teaching Human Factors (HF) courses for a very long time.

And in my more than two decades of training aircraft maintenance personnel both in the United States as well as abroad, a common theme is noticeable — there can be a stigma associated with HF training. Aviation Maintenance Technicians (AMTs) are often put into these classes (sometimes at the last minute) thinking that HF training is “for people who screw up.” And, because of that, many attendees feel that this type of training “doesn’t apply to them.” This attitude can be found in Initial, as well as Recurrent, HF courses. The stigma is certainly understandable. In most cases, course attendees have not been briefed, or given a heads-up, about the real purpose of HF training. So, let’s try to eliminate the stigma and assuage any fears that you are being “sentenced to a class for clutzy mechanics.”

By definition, “Human Factors is a multidisciplinary effort to generate

and compile information about human capabilities and limitations and apply that information to equipment, systems, facilities, procedures, jobs, environments, training, staffing and personnel management for safe, comfortable, effective human performance.” (FAA Order 9550.8 Human Factors Policy).

Okay, that’s a good start. The FAA basically wants you to know how different factors can influence you on the job and affect your performance; factors that can cause you to forget things, do wrong things, skip steps, and deviate from procedures. So, yes, the training is there to help you improve your awareness of these factors so that you might think twice about skipping a functional check or not conducting a tool inventory after zipping up an aircraft. Everyone, at every level of the organization, can benefit from HF training. In fact, the error that you do not make (as a result of the HF training) may save hundreds of lives, including your own, or your family’s. HF is certainly not a “class of shame.”

Your instructor knows that you are a consummate professional, not an error-prone employee singled out to serve an HF course sentence. During, and after the course, you will most likely embrace the new attitudes, skills, and knowledge you absorbed. In fact, you may be pleasantly surprised! I’ve had students come into the course with a bad attitude but finish the course with nothing but praise for a “very useful and enjoyable training class.”

In order to get this result, the training needs to be developed using adult learning principles in a facilitative fashion. Too much theory should be avoided. The course should be very interactive and include activities, exercises, and videos (but not too heavy on the videos). Course attendees should know that HF training is a much different experience than any other courses they have sat through before. And





when I say “different,” I mean that in the most positive way. It’s all about the soft skills!

But, if the course is so good, why is no one from Management in the class? I’m glad you asked! Well, it’s probably not as much about stigma as it is a general lack of motivation and time management. Managers may believe that they do not need to participate in human factors training because, “We don’t need it, it’s only for mechanics,” “We don’t make mistakes,” or, “We just don’t have the time for this kind of training.” Sound familiar?

Obviously, Managers do make errors. In fact, some of the most vivid aviation accidents have been precipitated by management errors made at the very highest levels of organizations. But even as history repeats itself with bad management decisions leading to accidents, there still appears to be a mindset of “error insulation” for those in management positions (in other words, “it won’t happen

to me”). When this type of management attitude permeates an organization, it can have negative consequences. It can negatively affect an organization’s safety culture. Management is not only about making strategic business decisions and watching out for the bottom line—it also serves as a model of safety behavior that is clearly visible to employees at all levels of the organization. Thus, if employees see that Managers are not attending the HF course, then it will certainly diminish the importance of HF training to the AMTs.

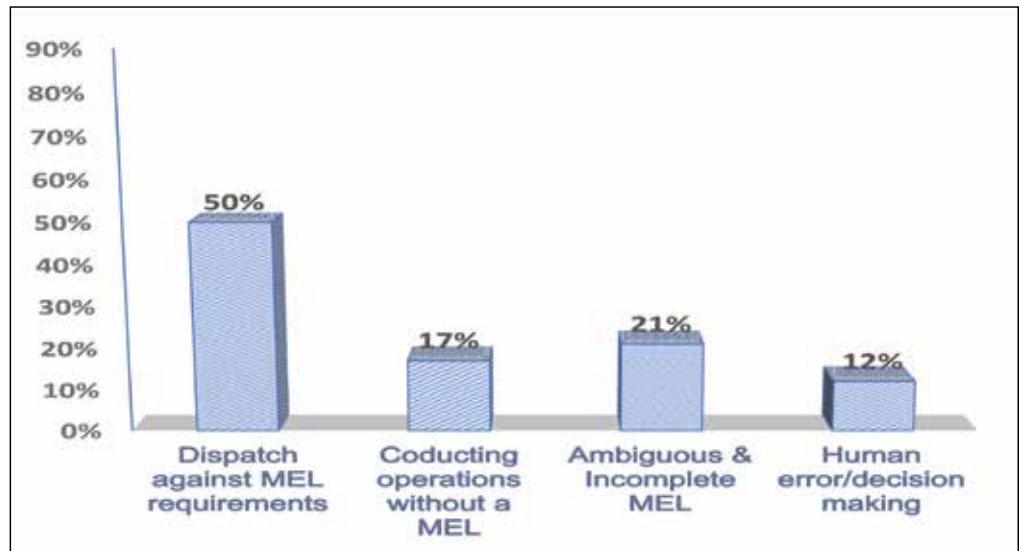
Hopefully, this article provided some useful information for those of you who have the HF training stigma and/or fear of the unknown. A well-developed HF course, with an effective facilitator, will be a very good experience for you. And it will also make you a safer employee. Oh, and try to get Management to attend the course. After all, we are all human—and we all make mistakes! **AM**

# Aircraft Minimum Equipment List: Current Practice and the Need for Standardization

Introduced in the late 1960s as part of airworthiness requirements, the aircraft minimum equipment list (MEL) is a document with a list of aircraft components or systems that may be inoperable for dispatch. Prior to the use of MEL, aircraft dispatch was a topic of negotiation between aircraft operators and regulators. Have things around the aircraft MEL changed since its institutionalization? Can we still rely on non-standardized and reportedly ambiguous guidelines to manage this airworthiness topic under the ever-increasing complexity of modern aircraft

has been a topic of discussion for both researchers and aviation professionals, and the reliability of the document has been questioned. In fact, it has been postulated that there is a need for a systematic approach to MEL development and approval.

Several principles govern the justification, approval, and management of the MEL document. Amongst others, the MEL must be more restrictive than the MMEL and must be developed based on the environment the aircraft would be operated. Regardless of the differences in MMEL development and approval

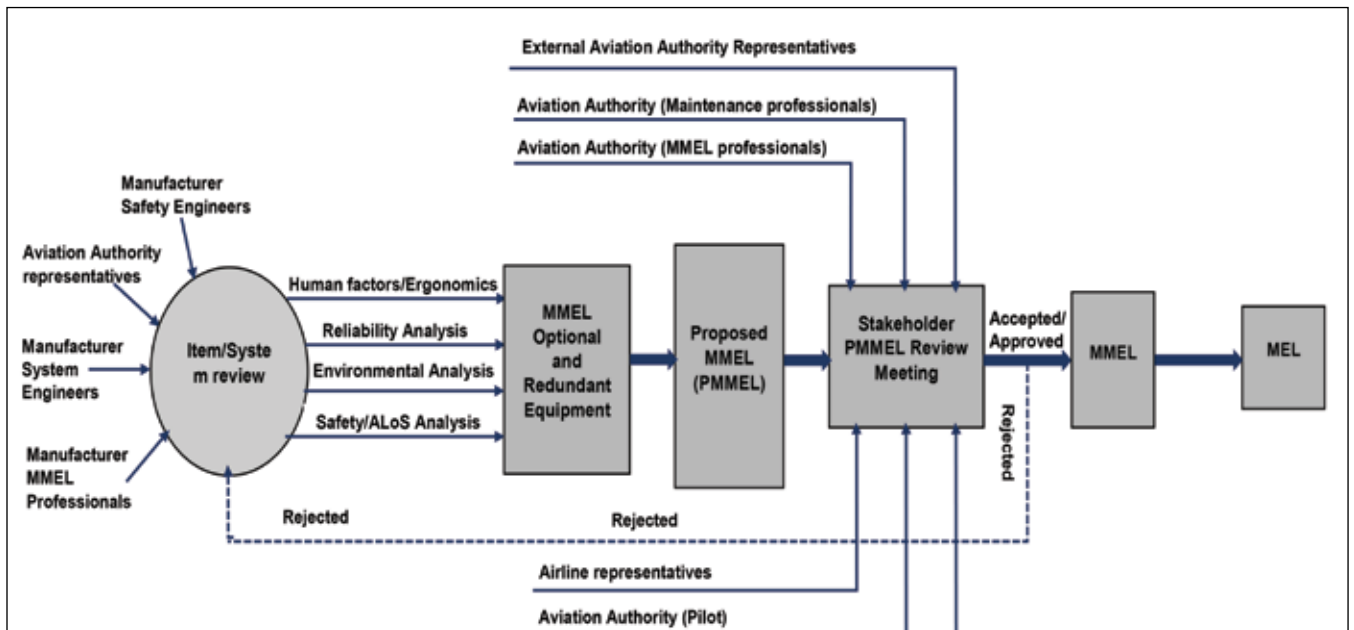


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and the dynamic environment within they operate? This article provides a summary of the current state of this very important airworthiness matter.

Aircraft manufacturers produce the master minimum equipment list (MMEL), and operators are required to develop their MELs based on the master document. While this approach is acceptable, the complexity of operating modern aircraft systems in diverse environments and mission profiles requires a more systematic approach. In recent years, the MEL

process in different regions, acceptability and technical accuracy of the document is checked by the stakeholders (such as safety and airworthiness personnel) involved in the process. They review and analyze the items/equipment listed whilst considering environmental and human factors, the reliability, and acceptable level of safety of each component/system. Figure 1 depicts the MEL development and approval process. During this phase, a thorough analysis is conducted before including a system/component in the list



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using techniques and tools such as Fault Tree Analysis (FTA) and Failure Mode and Effects Analysis (FMEA). While these tools have proved useful and yield satisfactory outcomes, they are still limited because they are linear and do not consider the interactions between humans and machines.

To understand the current state of this important airworthiness topic and also validate the need for a standardized approach, we reviewed MEL related literature, analyzed safety investigation reports of MEL-related events to detect current practice and issues that can affect the MEL development and use and warranty interventions. Figure 2 provides a summary of the MEL events reviewed. Aircraft dispatch against MEL requirements topped the list at 50%, followed by cases of operating aircraft without an approved MEL at 17%. Also, ambiguous and incomplete MEL-related cases accounted for 21%, while human error/decision making regarding MEL application and management was at 12%. In addition, amongst others, the literature reviewed revealed that:

- A holistic approach is required to streamline the development of a MEL framework and also manage the document.
- An engineer/pilot type-rated on an aircraft does not guarantee the correct interpretation of the aircraft's MEL.
- There is a need for prior airworthiness experience and MEL compliance training in order to properly apply and manage the MEL.

The aforementioned challenges present an opportunity to conduct further research into MEL. The MEL development process is dynamic and requires a combination of quantitative and qualitative approaches that encompass socio-technical and systems engineering principles. This will comprise the basis for a holistic and systematic methodology for MEL development and management.

The full article of this study can be viewed and downloaded for free on the website of the MDPI Aerospace journal at: <https://www.mdpi.com/2226-4310/7/1/7>. This article belongs to the Special Issue "Civil and Military Airworthiness: Recent Developments and Challenges." [AMI](#)



## SMS: Making It Useful Part Two Risk Assessment and Likelihood

**S**afety Management Systems: they seem complicated. But Aviation Maintenance Magazine is aiming to make them simple to implement.

In the January issue, we examined some hazard identification strategies. Because of Covid-19, we diverged from our expected series to bring you news about Covid-19 legislation in the March issue. But now we're back to SMS(!) and this month, we'll begin looking at the process of using risk assessment to analyze our identified hazards. If you don't remember how to identify hazards, then look back at the January issue to refresh your memory (it is available online).

The point of identifying hazards is to identify the things that could go wrong in your system. In the January issue, we suggested documenting hazards in a centralized and comprehensive hazard log. We specifically recommended using a database. A database will allow you to analyze trends in hazards, reference the mitigations associated with each hazard, and even serve as a tool for change management (we will address all of these in future articles). Before we can start tying our hazards to mitigations, though, we are going to first examine how to assess the risk posed by each hazard.

### We assess risk for a number of reasons.

One reason for assessing risk is to better allocate limited resources. If you know that you have three hazards that you could mitigate, but you can only mitigate then one at a time, then having a mechanism for deciding which hazard is most important to address would help you to decide how to allocate your resources.

A second reason for assessing risk is to decide when you have done a sufficient job in reducing the risks posed by the hazard. By assessing risk, you can set a metric for when risks are considered to be adequately contained. This tells you, *prima facie*, when a mitigation is considered to be "good enough."

A third reason for assessing risk is to permit the system to engage in constant improvement. If you assess the risk levels posed by a set of hazards, then you can mitigate the risks to the acceptable level that has been set by the company. Once the known hazards have all been mitigated to the acceptable level, the company can decide to pursue a higher level of safety by changing the acceptable level of risk! For example, if you create a system that assigns risk values to hazards, and you successfully build a system that mitigates all of the hazard-based risks to a value of 10 or less, then after achieving that goal, you might next seek to mitigate the risks valued at 9 and 10 to a value of eight or less.

A fourth reason for assessing risk is to have a mechanism for judging your company's progress on the safety continuum. By assessing and assigning numerical risk values to each hazard, you have an opportunity to record and assess the progress your

company is making on its path toward safety. You can set risk-based goals ("performance indicators") like reducing every risk below a certain metric or reducing the average of all risks in a system below a metric.

### So what does it mean to assess risk?

We typically assess risk in an SMS system by assigning two values to each hazard. The first value is "likelihood," and the second value (which we'll examine in next month's article) is consequence. Together, they can provide a measure of the risk posed by a particular hazard.

Likelihood reflects the prospect that the hazard condition will manifest itself. The purpose of this assignment is to rank more likely occurrences higher than less likely occurrences. Therefore it is typically not an absolute measure of probability. The values used may vary based on the system, and the needs of the system. For example, in a manufacturing environment, you might assess likelihood values related to failures of the manufactured product based on probability of hazard occurrence per operational hour. In the FAA Certification system, a likelihood measured at one occurrence in less than 100,000 hours of operation is considered to be probable; while a likelihood measured at one occurrence in more than 1,000,000,000 hours of operation is deemed to be extremely improbable. These two metrics reflect the bookends of the likelihood range in an FAA certification project. The United States military uses safety management and deems a hazard to be probable if it will occur several times in a system, but has another value – frequent – which describes hazards that are likely to occur frequently in the life of a system. In other systems, the values may distinguish hazards that will certainly arise in the life of a system (100% chance) from those that are expected but may not arise 100% of the time, to those that are remote in the sense that they have not yet arisen but are nonetheless feasible.

The scale that you use should be tailored to the particular hazards in your system, and the best factors that will provide you with meaningful distinctions to permit useful differentiation among the hazards being analyzed. For example, FAA certification distinctions may not be appropriate for a repair station, because the repair station may want to identify hazards that happen every day and distinguish them from those that happen once per week and distinguish those from hazards that arise once per month. All three categories likely fall into the "probable" likelihood on the FAA certification scale but if they all fall into the same category then the likelihood metric is not being successfully used to distinguish them.

In a repair station environment, you will encounter hazards such as human factors issues that arise on a more regular basis than the basis described in the FAA Certification probabilities,



Likelihood Level	Likelihood Description
1	Never has occurred and the hazard is unlikely to ever occur
2	Never has occurred but the hazard could reasonably occur
3	Has occurred, and without mitigation, the hazard would probably occur less often than once per month OR never has occurred but the hazard is likely to occur in the future
4	Has occurred, and without mitigation, the hazard would probably occur more often than once per month
5	Has occurred, and without mitigation, the hazard would likely occur on every project

so the FAA Certification range probably does not provide the appropriate metrics for judging the likelihood of hazards in a repair station. For purposes of this article, we shall use the rating scale in the chart above as our likelihood values.

Notice that these values are based on narrative descriptions, rather than hard numerical probabilities. This is because the typical repair station may be unable to classify its hazards based on strict numerical probabilities. A repair station will also have to consider the scope of the narrative descriptions (which may be based in part on the sources of hazard data). For example, if you are examining the failure of a particular OEM part, then the

repair station's experience may suggest it is a level 2 likelihood ("never has occurred but the hazard could reasonably occur"); but expanding the scope to include data from other repair stations might shift it to level 3 ("has occurred, and without mitigation, the hazard would probably occur less often than once per month OR never has occurred but the hazard is likely to occur in the future").

Let's say that the hazard in question is the release without final inspection of a unit that was subject to overhaul procedures. Let's also say that this hazard is identified because it occurred in the facility. Because it actually happened, this

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automatically gives it a level 3,4, or 5 likelihood (based on the definitions, above). It might be assigned a risk level based on past experience (if this has happened before, then the prior occurrence experience might help assign a likelihood level) or based on the intuition of the inspector responsible for the assignment. In this scenario, there is no precise answer, and therefore it makes sense to have one person or one group assessing the likelihood level in order to ensure risk assignments follow a reasonably standard pattern (so you do not have radically different risk assignments based upon different opinions of the narrative descriptions).

Because different people can come up with differing opinions about likelihood, a more objective standard can be valuable (so please do not assume that the likelihood values in the above table reflect an ideal). When you are establishing likelihood values and narratives, don't be afraid to adjust them to suit the needs of your business (including the need to distinguish more-likely events from less-likely events). If you do adjust your values, though, then you may need to re-analyze past risk assessments to update them to the new standard so you can compare hazards according to the same metrics.

The table on the previous page includes four different levels. Your table may include more or less levels. The

important thing is that the table you develop for your own system must distinguish among hazards in a way that is useful to your analysis of those hazards.

Your likelihood assessments should permit you to distinguish hazards based upon the difference in the likelihood. If likelihood was the only metric that you used, then this would permit you to focus first on the most likely hazards, and then save the less likely hazards to be mitigated later.

Likelihood is not the only metric we typically use to assess risk. Next month, we will examine the metric known as "consequence," which will help us to distinguish the most damaging hazards from the less damaging hazards. Using likelihood and consequence together, we will be able to judge which hazards pose a greater risk to safety.

### Part III of SMS Series Next Issue

In the next issue, we'll look at the process of using "consequence" as part of our risk assessment, and we will examine how to examine our identified hazards in a risk assessment environment. Want to learn more? We've been teaching classes in SMS elements, and we've advised aviation companies in multiple sectors on the development of SMS processes and systems. Give us a call or send us an email if we can help you with your SMS questions. [avi](mailto:avi@aviationmag.com)

The banner features a central puzzle grid with the following sections:

- Avionics**: Image of a cockpit with a scale icon.
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- MRO IT**: Image of a technician in a yellow vest with a gear icon.
- AEROSPACE testing**: Image of an engine component with a fan icon.
- Flight Ops IT**: Image of an airplane on a tarmac with a plane icon.
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