

# AVIATION MAINTENANCE

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Autumn 2021

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## **PARTS TRACKING**

NEW TECHNOLOGIES  
THAT CAN ASSIST

## **TRAINING IN THE DIGITAL AGE**

IN SPIITE OF MANDATES,  
CHANGE IS SLOW

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FUNCTIONAL AND  
BEAUTIFUL OPTIONS

# Human Factors and Procedural Non-Compliance **CONFRONTING THE CHALLENGE**

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+44 (0)20 3892 3050  
+1 (920) 214 0140

### EDITORIAL

**Editor-in-Chief**  
Joy Finnegan  
[jfinnegan@avm-mag.com](mailto:jfinnegan@avm-mag.com)

### Contributing Editors

|                 |                  |
|-----------------|------------------|
| James Careless  | Kathryn Creedy   |
| Aimee Turner    | Ian Harbison     |
| Jason Dickstein | Dale Smith       |
| Jeff Guzzetti   | James T. McKenna |

### ADVERTISING/ BUSINESS

**Publisher/Owner**  
Adrian Broadbent  
[abroadbent@aerospace-media.com](mailto:abroadbent@aerospace-media.com)

### Group Publisher & Sales Director

Simon Barker  
[sbarker@aerospace-media.com](mailto:sbarker@aerospace-media.com)

### Business Development Director

Anthony Smith  
[asmith@aerospace-media.com](mailto:asmith@aerospace-media.com)

### Key Account Director

Jina Lawrence  
[jinalawrence@avm-mag.com](mailto:jinalawrence@avm-mag.com)

### DESIGN/PRODUCTION

Lisa Garrison  
[lgarrison@aerospace-media.com](mailto:lgarrison@aerospace-media.com)

### CLASSIFIED AD SALES

Paula Calderon  
[pcalderon@aerospace-media.com](mailto:pcalderon@aerospace-media.com)

### CLIENT SERVICES

**Administration**  
Maria Hernanz Reyes  
[maria@asi-mag.com](mailto:maria@asi-mag.com)

### LIST RENTAL

**Statistics**  
Jen Felling  
[felling@statistics.com](mailto:felling@statistics.com)

### REPRINT PARTNER

The YGS Group  
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ASI Publications Ltd  
1 Coyners Avenue  
Southport  
PR8 4SZ  
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[abroadbent@aerospace-media.com](mailto:abroadbent@aerospace-media.com)

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# Cut the Red Wire, But First...



BY JOY FINNEGAN  
EDITOR-IN-CHIEF

**H**uman factors in aviation maintenance is a topic that never gets old for me. Understanding how our human nature can lead to being lax on the job, thinking we have a better way and holding biases impact the work in hangars and on aircraft is paramount to preventing those things from causing errors. And reducing errors is always the goal.

We have covered human factors over the years but felt the time was right to revisit this topic and take a look at some of the things we can do to improve our work. The nature of the task, the workload facing maintenance workers today, the working environment, the design of the work environment, tools used and the role of procedures in accomplishing the complex work of maintaining aircraft is essential to getting it right.

One issue that is intertwined with human factors is failure to follow procedures. A study commissioned by the Federal Aviation Administration (FAA) states that "Procedure not followed re-occurs with depressing regularity in incident and accident reports in aviation." Other researchers list Failure to Follow Procedures (FFP) as the number one cause of maintenance mishaps. The FAA study published in 2017 is still an excellent source of information about this and is worth a read. Their results showed that the top three areas of concern were the validity and availability of the procedure documentation, the difficulty of the task being performed, and the organizations social rules/norms.

Work culture, starting from the top leadership all the way to the hangar floor is the linchpin of any organization's safety and commitment to making efforts to improve. Individuals also play a key role in adhering to procedures, improving skills, continuing education, training and rooting out new and better ways to work by following the proper system of making changes.

Having a solid safety management system (SMS) can be a good way to include and address human factors and should be part of regular training within any risk control program. Addressing how human factors impact employees can yield multiple benefits like higher productivity rates, better safety and fewer on job injuries, less rework and, of course, saving money. For more on SMS, please check out Part 7 of Jason Dickstein's SMS series in this issue starting on page 46. Parts 1-6 of his series can be found on our website.

There are excellent resources at FAA.gov free for the taking. One is a course called "FFP: The Buck Stops With Me" and is a great starting point for training or even conversations in meetings as a way to keep the topic top of mind for employees.

Also at FAA.gov the "Dirty Dozen" is available for download. Most people know about and have read through these. If it's been a while, I highly recommend reviewing these twelve human factors hot topics like complacency, distractions, stress and poor communication. Some may find the cartoonish way they are depicted off-putting but don't let those cartoons mislead you. This resource is full of excellent information and suggestions for counteracting these pitfalls. It makes for great safety meeting discussion points — I guarantee if you open up a conversation in a safety meeting with one of these twelve and review the info from the Dirty Dozen flyer with your team, there will be a lively discussion about it.

For more in-depth information, please read our story on human factors and the problem of failure to follow procedures written by Jim McKenna, starting on page 16.

In lock step with human factors is training. In this issue we take a look at the state of maintenance training. Writer Kathryn Creedy takes a look at how the FAA has been congressionally mandated to reform Part 147 training and yet the changes don't seem to be happening. In spite of this situation, new training technologies such as Virtual Reality (VR) and Augmented Reality (AR) are being implemented around the world.

Companies are demanding better trained mechanics and technicians. They want workers that are well-versed in the current technologies of today, not the wood, dope and fabric of yesteryear. Flexibility to add or adjust curricula is going to be crucial as technology rapidly advances. Our update of the challenges being faced in training the next generation of A&P mechanics and avionics technicians starts on page 30.

We also take a look at parts tracking in this issue starting on page 22. This piece written by James Careless gives insight into new technologies that can help the ever-present challenge of finding the right parts, close by or as close as possible and getting them quickly, in spite of the current supply chain challenges (see the cover story in the summer issue of **Aviation Maintenance** called Better Faster Stronger — How to Fix the Aerospace Supply Chain).

Ian Harbison also provides a comprehensive look at hangar and hangar door developments. There are some incredibly innovative solutions out there for both hangars and doors. Whether you need a large temporary structure that can be relocated at a future date or a door system that can open and shut quickly, there are options that can satisfy the most unique challenges all while looking architecturally stunning. Check out this story on page 38.

Hope you enjoy this issue and the upcoming holidays — here's to a fabulous 2022! **AM**

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## United Opens New Maintenance Facility at Los Angeles International Airport

United has officially opened a new aircraft maintenance facility at Los Angeles International Airport (LAX) that modernizes maintenance infrastructure, facilitates efficient aircraft movement, and streamlines logistics of employees, support equipment, tooling, and parts while supporting the airline's overall growth in Los Angeles.

United executives were joined by members from the city and LAWA for a grand opening ceremony celebrating the \$352 million state-of-the-art facility that's nearly the size of three football fields or enough room for two, double-aisle aircraft or six single-aisle aircraft at a time.

"This new aircraft maintenance center is yet another investment United is making in the Los Angeles community, and particularly one that will allow us to operate a reliable airline and offer flights to exciting places across the globe," said Tom Doxey, senior vice president of United's Technical Operations. "This facility is not only a key component that will allow us to efficiently support our operations, but a state-of-the-art facility that will make the employees who work here proud to call United their home."

The new maintenance facility replaces and consolidates two facilities United previously operated at LAX that were located a mile and a half apart. The facility will be home to more than 500 United employees and includes a parts warehouse, an engine buildup shop and an extensive ground service equipment maintenance shop. More than 800 construction workers were employed for the building of this facility.

"We're incredibly proud of the role we play connecting the Southern California community to the world," said Jonna McGrath, managing director of Airport Operations at United's LAX hub. "United has served the Los Angeles community for more than a half century and the actions we are undertaking will have a transformational effect on our customer experience for years to come."

United recently announced the purchase of 270 new aircraft, the largest order in the company's history, that will drive growth in all the carrier's U.S. hubs, including LAX. The aircraft

order will help the airline grow the number of LA flights, give local travelers access to more inflight features and seat choice, and will help create up to 1,400 well-paid jobs in the region across various workgroups. In the past year, United has already added nine brand new flights from LA to Latin America, a new flight directly to JFK in New York City, two new flights to Florida destinations and plans to operate more than 120 daily flights from LAX this December.

"LAWA and United Airlines have a long, shared commitment to innovation, exceptional guest experiences, and the highest level of safety and security for guests at LAX," said Justin Erbacci, Chief Executive Officer, LAWA. "The planning and construction of the



United held a grand opening ceremony celebrating their \$352 million state-of-the-art facility at LAX that consolidates two of the two previous facilities the company was using. United images.

new Technical Operations Center is the latest example of United's commitment to LAX, and we congratulate their team on this impressive facility."

"One of the important roles of the Los Angeles Board of Airport Commissioners is to be a good steward of Los Angeles World Airports' finances and also the environment," said Commissioner Gabriel Eshaghian. "This state-of-the-art facility was built at no cost to LAWA, and will help improve airfield efficiency by consolidating United's maintenance in one location, making this a win-win for LAX and United Airlines. We look forward to our continued partnership as United continues to invest in LAX and the Los Angeles community we serve."

LA is one of United's most important coastal gateways with convenient access to destinations throughout the Pacific and, increasingly, Latin America. Combined with the company's recent \$573 million terminal renovation and new United Club and Polaris lounge, United has invested nearly \$1 billion at LAX since 2016, underscoring its importance to the airline's network. United operates every flight from LAX powered in part with sustainable biofuel.

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## Tamarack Disputes Findings of Probable Cause by NTSB Concerning the 2018 Citation Jet Accident

Tamarack cites facts and evidence showing that Tamarack's Active Winglets, installed on the CitationJet involved in the November 30, 2018, fatal accident, were fully operational and did not cause or contribute to the accident. We disagree with the National Transportation Safety Board's (NTSB's) Final Report today that concludes Active Winglets installed on the aircraft N525EG were the probable cause of the accident, alleging there was, "asymmetric deployment of the leftwing load alleviation system for undetermined reasons." The forensic evidence collected in the investigation indicates that the load alleviation system was indeed operational, and deployed symmetrically, upon impact. There are inconsistencies within the report that do not support the conclusion published by the NTSB.

Of particular note, the NTSB Final Report acknowledges that the aircraft was rolling at 5 degrees per second when the autopilot automatically disconnected at 30 degrees of bank, not at 45 degrees as would be the case for an excessive bank condition caused by an uncommanded roll. The investigation fails to explain or address the fact that the autopilot disconnected for other reasons.

Tamarack has fully cooperated with the NTSB during the investigation. The NTSB published a revised Factual Report on October 5, 2021, and just one month later published the Final

Report, without taking into consideration facts that indicate other causes could have caused the accident, as the Active Winglet modification was fully operating. Tamarack addressed this in a recent submission, that was ignored by the NTSB. The submission can be read here:

The NTSB Final Report also includes information that the pilot was able to attempt some corrective action late in the flight at very high speeds, but fails to address that an Active Winglet failure would have been easier to recover at slower speeds. These inconsistencies and missing factual elements could be material clues for understanding what caused or contributed to the accident, which could ultimately help the industry prevent other similar accidents.

Tamarack extends its deepest condolences to the families and friends of those who died in the 2018 tragic accident. That said, we believe all parties and aviation as a whole are interested in considering all the facts of the accident, resulting in an accurate probable cause finding by the NTSB that will lead to preventing future accidents involving aircraft. Tamarack intends to request the NTSB reconsider its finding, as per its own procedures. Tamarack will provide a more detailed response after further consideration of the NTSB's recent announcement.

## FlightSafety Selected by Breeze for A220 and E190 Training

FlightSafety International has been selected by Breeze Airways to provide Airbus A220 and Embraer E190 Full Flight Simulators (FFS) and Flight Training Devices (FTD).

As part of a long-term agreement, FlightSafety will also maintain the operation of the devices and other crew training equipment for Breeze. FlightSafety is increasing its focus on training and equipment for the Commercial Airline Training market. The company is a leading provider of Airbus A220 training technology and has delivered nearly 40 E-jet Full Flight Simulators.

Breeze Airways is the new airline founded by veteran industry entrepreneur David Neeleman that started flight operations in 2021. The airline is currently flying to 16 underserved destinations in the U.S. and is intent on blending technology with kindness to provide a 'Seriously Nice' customer experience.

The initial simulators, engineered and manufactured by FlightSafety in Broken Arrow, Oklahoma, will be delivered to Breeze Training Academy in 2022. The simulators will incorporate industry-leading technologies for highest fidelity and reliability, and the A220 FFS and FTD will utilize Airbus' Standard 1.0 software.

"We are excited and proud to partner with Breeze," said FlightSafety President and CEO Brad Thress. "We're committed to providing the best training and technology support to the world's commercial airlines, and believe that our partnership with Breeze solidifies that."

"Breeze is diligent in selecting partners for long-term success,



FlightSafety Intl. and Breeze Airways are teaming up for training. FSI image.

and FlightSafety's vision and customer service made this an easy decision," said David Neeleman, Breeze Airways' chairman and CEO.

FlightSafety says it has improved synergies across the company, optimizing its manufacturing footprint and streamlining its build process. Customers are recognizing the benefits from FlightSafety's continued focus on advancing technology, improving supply chain partnerships, and providing comprehensive support.





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## Transavia Airlines to Mobilize Their Maintenance

TRAX announced that Transavia Airlines is adding their Line Control and QuickTurn eMobility apps to its maintenance environment. The airline is hopeful they will experience efficiency gains from going mobile and paperless.

eMobility apps are task-based and intuitive for end users with minimal training required and enhanced productivity achieved. Users access real-time information and are connected from anywhere with mobile off-line capability. Reduced aircraft maintenance delays, combined with reductions in labor manhours, result in savings and operational efficiency, TRAX says.

Transavia, a subsidiary of Air France KLM Group, is a Dutch low-cost airline established in 1965 that offers charter and scheduled flights to summer and winter holiday destinations in Europe and the Mediterranean and carries 11 million passengers a year.



## IAI to Convert B777-300ER Passenger Aircraft to Cargo Configuration for Emirates



Israel Aerospace Industries (IAI) signed an agreement to convert four B777-300ER passenger aircraft to cargo configuration for Emirates. The aircraft will be converted at the new site established in Etihad Engineering's MRO center in Abu Dhabi, and the first conversion of the Emirates plane is expected to begin in early 2023. The agreement has potential to provide passenger-to-freighter conversion services to more aircraft.

Dubai-based Emirates is the largest operator of B777-300ER aircraft in the world and Emirates SkyCargo is a player in the

global air cargo industry. The two companies say this agreement between IAI and the cargo division of Emirates is a testament to the strong ties between IAI and the UAE.

## EDGE Partners with Sanad to Provide MRO Services for Rolls Royce Trent 700 Engines

GAL, a regional provider of integrated aircraft sustainment solutions for military and civilian customers within EDGE Group, have signed an agreement for Sanad to provide Rolls-Royce Trent 700 engine maintenance services to support GAL's Performance Based Logistics contract with UAE Air Force Air Defence (AFAD).

The agreement establishes a new foundation for the delivery of world-class MRO services for Rolls Royce Trent 700 engines that power the UAE's Airbus A330 Multi Role Tanker Transport (MRTT) fleet. Through shared knowledge and a rich tradition in aviation excellence, GAL and Sanad will provide MRO support to service the engines, reducing current turnaround time and shop visit costs by eliminating the need to ship engines outside the UAE.

"We look forward to working with Sanad to facilitate ongoing growth across the UAE's burgeoning aviation sector," Khalid Al Breiki, president of Mission Support at EDGE, and managing director of GAL, said. "This is a strategically important partnership between two national entities which has great significance for indigenous future technologies, supporting local talent and capabilities and ultimately contributing to the UAE economy. As the region's leading MRO provider, we continuously take pride in collaborations which may support the ongoing defence initiatives within AFAD and the UAE. Sanad's contributions to GAL will be another key component in delivering cutting-edge maintenance capabilities within the region."

Mansoor Janahi, deputy group CEO of Sanad, said, "As the latest milestone in Sanad's long-standing MRO services journey, this agreement marks a major step in our strategic long-

term collaboration with GAL and EDGE. Having established market-leading MRO expertise by servicing leading global OEMs and airlines, Sanad's extensive engine MRO infrastructure and capabilities, including the unique capabilities that we have on Trent 700 for more than 10 years driven by local knowledge sharing and underpinned by a commitment to develop national talent — will serve as the foundation for this exciting new partnership."

Sanad says they are currently the only independent Trent 700 MRO facility worldwide. Sanad works in partnership with major original equipment manufacturers (OEMs) including Rolls-Royce, GE Aviation and International Aero Engines and provides a variety of engine maintenance services across multiple major aircraft platforms, including Airbus and Boeing.



## NTSB Concludes Maintenance Error Led to Fatal Runway Overrun Accident

A passenger turboprop airplane overran a runway because its braking system was compromised by incorrectly wired anti-skid sensors, the National Transportation Safety Board determined in a public meeting Tuesday. On Oct. 17, 2019, PenAir flight 3296, a Saab SA-2000, overran the runway during a landing attempt in Unalaska, Alaska. The airplane crashed through the perimeter fence, crossed a road, and came to rest on shoreline rocks on the edge of Dutch Harbor. One passenger was killed; another was seriously injured; and eight sustained minor injuries, mostly during the evacuation. The flight crew, the flight attendant, and the other 29 passengers were uninjured.

"Even though the airplane, the pilot, the weather and federal oversight all had a role in this tragedy, it was entirely preventable," said NTSB Chair Jennifer L. Homendy. "The brake system should have been designed to protect against human error during maintenance, the pilot shouldn't have landed on a runway with such a strong tailwind and federal regulators should have considered the runway safety area dimensions when authorizing the airline to fly the Saab 2000 into that airport."

A post-accident examination of the airplane revealed sensors for the anti-skid system had been incorrectly wired during an overhaul of the left main landing gear. This configuration led to the skidding and bursting of one tire and the subsequent release of brake pressure on two of the three remaining wheels. Investigators determined the loss of effective braking on three of the four main landing gear wheels prevented the flight crew from stopping on the runway.

Noting that systems should be engineered to prevent human errors that could occur during maintenance, the NTSB recommended Saab



redesign the landing gear wheel speed sensor wiring to reduce the probability of a miswiring during maintenance operations. Because the captain elected to land on a runway with a reported tailwind that exceeded the airplane manufacturer's operating limit, the airplane touched down with a higher-than-normal groundspeed. The NTSB said the decision to land with such a tailwind was "intentional, inappropriate, and indicative of plan continuation bias."

The NTSB also found that when the Federal Aviation Administration approved PenAir to fly in and out of the Unalaska airport with the Saab 2000, they did not recognize that the safety area beyond the end of the runway did not conform to the recommended safety criteria for an airplane in that design category.

The NTSB issued six recommendations to the FAA, three to the European Union Aviation Safety Agency and one to Saab. The final report will be published on the NTSB website in several weeks.

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## GAMA Awards Aviation Design Challenge Winners General Aviation Experiences

The winning team of the General Aviation Manufacturers Association (GAMA) 2021 Aviation Design Challenge, from Raisbeck Aviation High School, recently participated in its general aviation manufacturing experience. The team visited GAMA member companies to learn about general aviation manufacturing, which included hands-on experiences and demonstration flights.

"It truly was a pleasure putting together a memorable and exciting experience for the team from Raisbeck Aviation High School. This team was full of bright, talented students who were enthusiastic about aviation and learning more about the industry. They all have bright futures, and we look forward to following their prospective journeys in aviation," said Pete Bunce, GAMA president and CEO.

The team began their general aviation experience with a tour of Eviation in Arlington, Washington, to view the progress of the development of "Alice", an all-electric commuter aircraft, and learn about magniX's electric propulsion units. The team then spent four days at CubCrafters in Yakima, Washington, learning and receiving hands-on exposure to composites, metal fabrication, machinery, welding and the manufacturing assembly line. The team also participated in a Component Design Challenge, in which they worked with designers and engineers to design, prototype and test a sample headset hanger to be used in CubCrafters aircraft.

"Everyone at CubCrafters was amazed by the team's passion for aviation, eagerness to learn more about the entire manufacturing process and the enthusiasm they showed throughout the Component Design Challenge. This team of students showed great promise and we were proud to be able to offer them a one-of-a-kind experience which further intrigued their interest in general aviation. Programs like GAMA's Aviation Design Challenge do great work to promote the exciting and rewarding careers found in aviation to future generations," said Pat Horgan, CubCrafters president.

The Aviation Design Challenge second-place team, from The Pennington School, was also recently awarded its prize. The

students participated in a two-day STEM Lab Camp provided by Redbird Flight Simulations, which included learning on flight simulators.

"The students really enjoy the fun, engaging learning environment that is created through the hands-on training of a flight simulator, which engages their creativity and fosters their interests in STEM outside the classroom.

We value the opportunity to offer our STEM Lab Camp as a part of the GAMA Aviation Design Challenge and look forward to continuing to be a part of this valuable program," said Charlie Gregoire, Redbird Flight Simulations COO and President.

"The CubCrafters, magniX, Eviation and Redbird Flight Simulations teams did a remarkable job showcasing the diverse and rewarding jobs that encompass general aviation. We are grateful for their commitment, as well as that from our tremendous sponsors, to inspire students to pursue opportunities in our industry. We look forward to continuing this incredible experience especially as it enters its tenth year of promoting the future of general aviation," Bunce added.

Sponsors of the 2021 Aviation Design Challenge include Bombardier, Cirrus Aircraft, Click Bond, CubCrafters, Daher, Embraer, Eviation, Garmin, Gulfstream Aerospace Corporation, Hartzell Propeller, magniX, Redbird Flight Simulations, Signature Flight Support, Textron Aviation and Wipaire.

Registration for the 2022 Aviation Design Challenge is currently open. To register and to learn more about the challenge, please visit [gama.aero](http://gama.aero). Registration closes on December 17, 2021, or once all available slots are filled.



## Vertex Aerospace Recognized as Military Friendly Employer and Nation's Top Ten in Supplier Diversity Program

Vertex Aerospace announced today that it received the 2022 Military Friendly Employer designation and ranked number six in the nation on the 2022 Military Friendly Supplier Diversity Program list.

This is the third year Vertex has been recognized as a Military Friendly Employer. "With more than 60 percent of our workforce being Armed Forces veterans, this accomplishment aligns with our culture," said Ed Boyington, president, and CEO. We are extremely pleased to be recognized by Military Friendly as a desired employer. This award supports and highlights our efforts within the veteran community."

Vertex also ranked number six in the nation within the \$500 million to \$1 billion Military Friendly Supplier Diversity category. Generated each year, this ranking is based on extensive research using public data sources for more than 8,800 employers nationwide, and responses to the proprietary, data-driven Military Friendly Companies survey from participating companies. The survey questions, methodology, criteria, and weighting were developed with the assistance of an independent research firm. Ernst & Young, a global leader in assurance, tax, transaction, and advisory

services, independently evaluated the scoring methodology used for the Military Friendly Supplier Diversity Program list using the criteria set forth by the VIQTORY assessment survey.

"We are constantly looking for ways to support the veteran community," said Kelly Miller, senior vice-president of Vertex Aerospace Logistics. "We also recognize that the inclusion of veteran-owned business suppliers in our Supplier Diversity Program is critical to our economic growth, stability, and continued success, while also supporting our veterans and their families."

"Companies earning the Military Friendly Employers designation create and evaluate the standard for military programs across the globe, they have invested in substantive programs to recruit, retain and advance the veterans and service members within the organizations," said Kayla Lopez, director of Military Partnerships, Military Friendly. "To them, hiring veterans and service members is more than just the right thing to do. It makes good business sense."



## App for Portable, Fast Weld Inspection of Complex and Oversized Parts

The new WeldSight Remote Connect app for the OmniScan X3 phased array flaw detector streamlines the weld inspection workflow by enabling users to perform every step via WeldSight software on a PC or laptop. Combined with Olympus scanners and probes, this phased array ultrasonic testing (PAUT) solution minimizes manufacturing delays caused by inefficient nondestructive testing (NDT) methods.

### Improved Productivity for Large Weld Inspections

Manufacturers of oversized metal parts, from pressure vessels to wind turbine blades, must validate new-fabrication welds according to stringent international standards. Inspection bottlenecks can slow down production, with delays stretching into months.

With the WeldSight Remote Connect app downloaded on an OmniScan X3 flaw detector, the user can control the unit using WeldSight software on a connected computer. Thanks to this remote-control capability, the flaw detector and software combine to become an efficient, high-performance, portable inspection solution that is also cost effective. It provides manufacturers the flexibility to create customized equipment setups optimized for new weld inspections in oversized parts as well as complex configurations using multiple groups and probes, scanners and monitors to maximize the flaw detection coverage and visualization.

### Faster Workflow, from Setup to Analysis

Olympus says time is saved from acquisition to analysis since the

OmniScan X3 data is transferred instantly to the WeldSight computer. WeldSight software is equipped with specialized weld analysis tools and customizable data displays to optimize indication validation.

To ease flaw characterization and orientation, particularly for welds in large parts with complex geometries, WeldSight software provides a comprehensive image of the weld, enabling inspectors to merge distinct scan files and view the indication in detail from all sides. For additional scan plan flexibility, WeldSight software also offers an integrated ES BeamTool option, incorporating parameters for fabrication codes and a wide range of weld and part characteristics.

### Inspection That Keeps Pace with Production

The WeldSight Remote Connect app paves the way for high-productivity, off-the-shelf weld inspection solutions for manufacturers, exploiting the powerful PA, UT and TOFD data acquisition of the OmniScan X3 flaw detector and the advanced functionalities and customizable user interface of WeldSight software. The solution enables manufacturers to comply with international standards governing new-fabrication welds while keeping pace with production.



## LEARN HOW TO REDUCE SUPPLY CHAIN INCONSISTENCIES THROUGH BLOCKCHAIN

There is no single method to track and secure hundreds of millions of MRO Supply Chain records and transactions, increasing both risk and cost. And if there is any inconsistency between stakeholder systems, the risk of data overlap increases – as does cost.

Airlines face some of the most complex issues related to aircraft asset movement, from a lack of digital records to supply chain difficulties, system inconsistencies, and burdensome costs. Here at SITA, we believe that blockchain will be vital to solving these challenges.

Read our whitepaper here:

[www.sita.aero/mroblockchain](http://www.sita.aero/mroblockchain)



## Duncan Partners with Dassault Falcon Jet to Develop STCs for the ACA Ionizer in Three Falcon Aircraft

Duncan Aviation together with Dassault Falcon Jet has developed Supplemental Type Certificates (STCs) and installation packages for the Aviation Clean Air (ACA) ionization system for three Dassault Falcon models: the 7X, 2000/2000EX and 900/900EX aircraft, including all EASy variants. The Duncan Aviation Engineering and Certification Services team, in collaboration with the Duncan Aviation Organization Designation Authorization (ODA), has secured FAA approval for all three STCs and is now working on approvals from the European Union Aviation Safety Agency (EASA), Transport Canada Civil Aviation (TCCA), and Brazil's Agência Nacional de Aviação Civil (ANAC).

"We want to make it easy for our clients to keep the air in their aircraft as free of harmful pathogens and as fresh as possible" says Nate Klenke. "Our development of multiple STCs with PMA installation packages along with the experience we've gained from numerous installations makes Duncan Aviation an excellent choice for the installation or the source for the PMA packages that include the STC and all of the parts required for installation."

Each PMA package includes everything: every screw, nut, bolt, and switch necessary for the installation.

"There's been great interest in the industry in the ACA system. Our sales teams are fielding calls from customers who are interested in this system because it is designed to neutralize harmful pathogens like those that cause COVID-19, so if customers want peace of mind as they fly, this is the system for them," said Pat Mapes manager of Avionics Install Line.

The installation of the ACA ionization system can be done at any of Duncan Aviation's three main facilities (Battle Creek, Michigan; Provo, Utah; or Lincoln, Nebraska) and at many of the Duncan Aviation Satellite Shops located throughout the United States.

Designed to be installed in an aircraft's existing environmental control system, the ACA ionizers operate in the aircraft's



ductwork. The ionized hydrogen molecules neutralize pathogens and remove allergens and unpleasant odors, including those from pets, cigarette and cigar smoke, engine exhaust, cooking, and lavatories.

In May 2020, testing conducted by independent lab Innovative BioAnalysis found the ACA ionizer effective at rendering harmless the coronavirus that causes COVID-19. As we head into cold and flu season, it's good to know that the ACA ionizer also deactivates other viral, bacterial, and fungal pathogens, such as those that cause the common cold, flu (swine, avian, etc.), MRSA (methicillin-resistant Staphylococcus aureus), C. diff (clostridium difficile), E. coli (Escherichia coli), pneumonia, polio, and mold.

"Quotes for installing the ACA Ionization system have remained steady throughout the last year," said Steve Eloffson, senior avionics sales rep. "We're hearing from clients who have scheduled maintenance events or who are already going to be in Lincoln, Neb., or at one of our other facilities. This is one of those upgrades that our clients do when they're here for another event."

## Magnetic MRO Completes 700th C-Check



Magnetic MRO has reached a milestone – the successful completion of their 700th C-Check. The company says this milestone emphasizes that, despite the global pandemic, the company is still going strong.

The 700th C-Check has been performed on A320 NEO aircraft, operated by Scandinavian Airlines (SAS). The aircraft was delivered to Magnetic MRO hangars in Tallinn, Estonia, on 23rd of October and the C-Check

was completed within a few days from the delivery.

"We are delighted to announce this milestone Base Maintenance has passed — it showcases the increase of our pace year-on-year: if previous milestone of 600th check has been achieved after 17 years of Base Maintenance operations in Estonia, then the next 100 checks have been performed just within two years despite all the challenges brought by the recent pandemic. Besides, it is also our pleasure to celebrate this symbolic milestone and 700th C-Check completion on brand new Scandinavian Airline's A320 NEO aircraft as the operator has been our long-standing client," said Sergei Shkolnik, director of Base Maintenance at Magnetic MRO.



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## WHY PROCEDURAL COMPLIANCE IS CRUCIAL TO AVIATION MAINTENANCE

# CONFRONTING THE CHALLENGE OF FAILING TO FOLLOW PROCEDURES





## James T. McKenna

**M**ore than three decades after a 737 ripped open over Hawaii and stunned the flying public with the dangers of human error in aircraft maintenance, the aviation industry is still challenged to contain that risk and keep crews and passengers safe in the air.

The toughest hurdle is persuading aircraft operators, manufacturers, vendors and their maintenance technicians to comply with procedures.

The industry has made great progress since April 28, 1988, when the top of an Aloha Airlines Boeing 737's fuselage tore free at 24,000 feet. A flight attendant

vanished and 94 others on board were terrified, with 65 injured. Images of them surrounded in the landed jet's front cabin by little more than moist island air and shredded metal shocked much of the world. It was vivid proof of the hazards in pushing aircraft beyond the eye's and brain's abilities to keep them flying safely.

The fuselage blew because a lap joint failed, then a lot of minor cracks around rivet heads opened up like a zipper. The NTSB said Aloha Airlines maintenance program failed to detect significant disbonding and fatigue damage that led to that. It found "difficult and tedious" 737 inspection procedures had "physical, physiological and psychological limitations."

### The Threat Persists

Spurred by the flying public and the U.S. Congress, regulators and the industry launched an effort to identify maintenance-error hazards, research their causes, find ways to reduce risks and field effective mitigation measures. Over three decades, inspection procedures and techniques were improved and maintenance standards made stricter. Yet incidents and accidents show repeatedly that the threat persists, particularly the biggest one: failure to follow procedures.

Most maintenance tasks have written procedures that they say must be followed and are intended to produce the same result every time. "However, the incidence of failure-to-follow-procedures events continues to be a major issue in aviation maintenance," three researchers reported in 2017.

Colin G. Drury and Catherine Drury Barnes of Applied Ergonomics Group and Michelle R. Bryant of the FAA's Civil Aerospace Medical Institute had been tasked in 2015 with examining primary and contributing factors of failing to follow procedures and then developing mitigation strategies. Despite 30 years of research into procedural compliance, their report noted, "these challenges and recommendations have not changed a great deal in that time period."

In 2019, FAA chief maintenance human factors advisor Bill Johnson spoke with executives of large U.S. airlines.

"Without exception," Johnson, said, they told him "procedural non-compliance is the



Dr. Bill Johnson  
President, drbillj.com

unanimous No. 1 contributing factor" for maintenance-error events." (Now retired from the FAA, Johnson is principal scientist at drbillj.com.)

"Even as we speak, there are hundreds of mechanics probably deviating from procedures," said Robert Baron, president and chief consultant of The Aviation Consulting Group. He specializes in human factors and other safety training and issues, working with hundreds of aviation organizations around the



Bob Baron  
President, TACG

world. "Fortunately, it's a safe system. There are backups, redundancy, cross-checking and different types of oversight. But when something slips through, that could be potentially catastrophic."

### Consequences of Rule-Breaking

Baron's comment pointed toward an underlying reason for persistent procedural non-compliance, which Gordon Dupont explains with an everyday analogy. As a Transport Canada safety officer in the 1990s, Dupont crafted the noteworthy "Dirty Dozen" list of 12 human factors that can degrade your ability to perform effectively and safely and lead to maintenance errors. He is the retired CEO of System Safety Services in Richmond, British Columbia.

"What's the most common rule broken every day all around the world? The speed limit," Dupont has said. "The average driver will go between 5 and 10 mph over the speed limit unless the weather is bad, there is a police officer close by" or some other condition slows the driver down. "So why do we do it? The answer is very simple. We foresee no negative consequences in breaking the speed limit and the positive consequence of getting to our destination sooner serves to justify the rule-breaking. Rule-breaking at work goes along the same lines."

Overall, maintenance errors can appear to be a small problem. Boeing's analysis has long put maintenance as a primary cause of just 3 to 4 percent of hull-loss accidents and a contributing cause of about 10 percent. By comparison, flight crew actions are cited as a primary cause in more than 60 percent.

Analysis by the International Air Transport Association (IATA) found that



The NTSB said Aloha Airlines maintenance program failed to detect significant disbonding and fatigue damage that led to a lap joint failing. One flight attendant died and 65 of the 94 on board were injured. The image above shows the aircraft after landing on April 28, 1988. Image credit: [https://ritkanlathatortotenelem.blog.hu/2013/12/16/aloaha\\_823](https://ritkanlathatortotenelem.blog.hu/2013/12/16/aloaha_823).

“maintenance operations” were a latent condition in 21 percent of 2020’s airline accidents and “maintenance operations: SOPs and checking” was a latent condition in 13 percent. IATA’s safety analysts define a latent condition as one that is present in the system before an accident that is made evident by triggering factors (which often relate to deficiencies in organizational processes and procedures).

In 2020’s accidents, IATA said, maintenance was a threat in 21 percent. It defines a threat as an event or error that occurs outside the pilots’ influence but requires their attention and management to maintain safety margins.

From 2016 to 2020, IATA found, maintenance operations were a latent condition in 12 percent of accidents. For maintenance operations: SOPs and checking, the number was 11 percent.



John Goglia  
Partner, John Goglia LLC

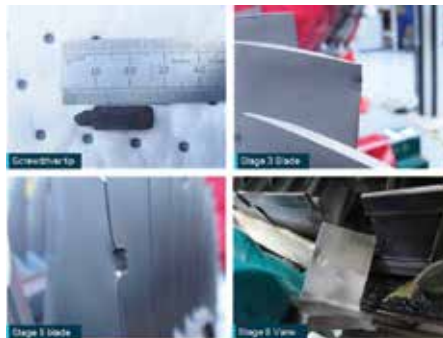
Maintenance was a threat in 14 percent over that time. From 2011 to 2015, maintenance operations and maintenance operations: SOPs and checking each were latent conditions in 7 percent of accidents and maintenance was a threat in 10 percent.

“We’re stalled,” said John Goglia, a retired airline mechanic and former U.S. National Transportation Safety Board (NTSB) member who has been a driving force in addressing maintenance human factors issues. “We need to look at our

history and do something different.”

## A Problem Lies in Wait

One recent incident illustrates how the failure to follow procedures can create a



An on-wing borescope inspection of this Jetstar Airways Airbus A320 found out-of-limit damage to the right engine’s high-pressure compressor (HPC) consistent with foreign object strikes. A teardown inspection confirmed substantial HPC damage, including a broken stage 5 blade and one stage 6 vane, four stage 7 blades and one stage 8 blade that were missing. A screwdriver tip was found between the combustion liner and engine case, burnt, discolored and eroded. ATSB image.

problem that lies in wait.

On Oct. 23, 2020, a Jetstar Airways Airbus A320-232 was taking off from Brisbane, Australia. As the IAE V2527-A5 engines spooled up, the pilots noticed a vibration and “popping” noise that rapidly increased in frequency and volume. They rejected the takeoff at 30 knots. Stall and temperature-exceedance warnings appeared for the No. 2 engine. They learned that passengers had reported flames coming from the right engine, as had the tower controller and a following flight crew. Recorded data indicated it had surged.

An on-wing borescope inspection found out-of-limit damage to the right engine’s

high-pressure compressor (HPC) consistent with foreign object strikes. A teardown inspection confirmed substantial HPC damage, including a broken stage 5 blade and one stage 6 vane, four stage 7 blades and one stage 8 blade that were missing. A screwdriver tip was found between the combustion liner and engine case, burnt, discolored and eroded from heat and mechanical damage.

The aircraft had been parked for four months. The return-to-service work included lubrication of the low-pressure compressor bleed valve mechanism. Procedures “contained specific highlighted caution notes regarding the loss of any screws or other loose objects down the bleed duct,” the Australian Transport Safety Bureau said in its Aug. 16, 2021 incident report. “The notes highlighted that lost articles would progress to the HPC and break valves and vanes.”

The bleed valve was lubricated 112 flight cycles prior to the Oct. 23 engine surge, the ATSB said.

## Helicopter Crew Gets Lucky

Sometimes negative consequences of procedural non-compliance are quickly apparent.

On June 1, 2020, the crew of a Northern HeliCopter AS365-N3 were alerted for a rescue mission from their St. Peter-Ording Airfield base, about 85 miles (138 kilometers) northwest of Hamburg on Germany’s North Sea coast. It would be the day’s second flight. The pilots used an approved “scramble” takeoff procedure that did not include a flight control hydraulic check.

The copilot increased thrust. The helicopter lifted to a hover, then immediately pitched up. The copilot lowered the collective. The tail struck the ground and the main landing gear touched down hard. No one was injured. The helicopter was slightly damaged.

The pilots determined that forward and backward cyclic inputs had no effect on the rotor disk. They shut down on the runway. Back in the hangar, they found that the left actuator was not connected to the swashplate that redirects the main rotor blades. Its fastener was missing. They found the bolt, two washers and one Nylon stop crown nut on the gear box compartment below. They did not find a loose cotter pin or parts of one.

Through mid-May, a contractor had performed substantial maintenance on the helicopter, including a main gearbox

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In this Northern HeliCopter AS365-N3 incident, the pilots found cyclic inputs had no effect on the rotor disk. After aborting the flight, they returned to the hangar and found that the left actuator was not connected to the swashplate that redirects the main rotor blades (see image above). Its fastener was missing. They found the bolt, two washers and one Nylon stop crown nut on the gear box compartment below. Operator, via BFU, images.



leak repair that required the left actuator's removal. A post-maintenance check flight was done. The repair was assigned to experienced mechanics and was checked by an experienced inspector. "However, that check had been signed a few days after the occurrence," said the Federal Bureau of Aircraft Accident Investigation (with the German acronym BFU), which investigated. The mechanics, inspector and maintenance pilot told the BFU in written statements that the actuator's screw fitting was properly installed and the cotter pin was positioned and visually checked several times before the helicopter was returned to the operator.

Those maintenance personnel "were certainly aware of the importance of the flight controls and were certainly familiar with different types of screw lockings," the BFU said in its report.

The BFU concluded the incident was most likely caused by mechanics using a worn Nylon stop crown nut on the

actuator-to-swashplate bolt, applying insufficient torque to that nut and not installing a cotter pin on it.

The BFU also concluded the inspector did not sufficiently check the mechanics' work and that two other mechanics failed to check the actuator connection as required by a 10-flight-hour/seven-day-inspection performed the day before the incident.

"It was just luck that during the occurrence — total loss of control — only the tail skid of the helicopter was damaged and more severe damage or even injuries to persons did not occur," the BFU report observed. Between its return from maintenance and the loss of control, the helicopter flew for a total of 8:46 flight hours.

## BA 787-8 Case Study

Another recent maintenance error made itself known much faster.

On June 21, 2021, a British Airways

Boeing 787-8 was being loaded at London's Heathrow Airport for a cargo flight. Three mechanics were tasked with clearing status messages about a nose landing gear solenoid valve. The procedure required cycling the landing gear with hydraulic power applied to the aircraft. To prevent the gear from retracting, the procedure required pins to be inserted in the main and nose gear downlocks.

The lead mechanic, in the cockpit captain's seat preparing for the job, told the other mechanics to place pins in the downlocks and ensure the four people loading cargo were clear of the aircraft. At the nose gear, the first mechanic could not reach the locking pin hole. He pointed to the hole's location and the second mechanic fitted the pin, which like the others had red and yellow flags attached. At the right main gear, the first mechanic used portable steps to fit the pin. He repeated that on the left gear.

The first mechanic returned to the cockpit to tell the lead the pins had been fitted. The two mechanics then returned to the nose gear and plugged a communications headset into the nose gear bay port. The lead requested confirmation again that the pins were in place. The first mechanic said they were.

The lead mechanic applied hydraulic power. Before moving the gear lever, he requested final confirmation from the first mechanic that the pins were in place and the cargo team was clear. This mechanic again visually checked that he could see the warning flags for each gear pin. He also checked that no feet were visible to indicate the load team was clear. He then confirmed this to the lead.

In the cockpit, the lead selected the gear lever to up. The nose gear retracted and the nose fell to the ground.

The worker on the pallet loader under the starboard forward cargo door was slightly injured as that door moved down when the fuselage dropped. The copilot, sitting in the cockpit, received a minor injury.

The nose crushed a ground power unit's articulated cable arm. The lower forward fuselage and nose gear doors were damaged, as were both engine cowlings (which also struck the ground). Door 2L struck the stairs positioned at its opening when the nose fell and was severely damaged.

When the recovery operation lifted the nose, the nose gear was examined and

the downlock pin was found fitted not in its hole but in the apex pin bore next to it.

## No Silver Bullet

Researchers talk of errors of omission (such as failing to install O-ring seals on turbine engine chip detectors) and of commission (such as using incorrect fasteners to install a cockpit windshield). There are timing errors (performing a task at the wrong time or in the wrong order) and precision errors (such as using the wrong setting on a torque wrench).

They also talk of perception errors ("I didn't see that") and slips ("I didn't mean to do that"), as well as wrong assumptions ("I assumed we returned to Stand 513, where the aircraft's integrated drive generator oil levels had to be checked, but we went to Stand 517"). There is technical misunderstanding ("I tried to replace the landing gear hydraulic-retract actuator, but I didn't understand what I had to do").

One of the most common maintenance errors involves a mechanic forgetting to do a task planned for completion before a job is closed out, such as removing an engine thrust-reverser lockout pin after investigating an engine bleed-air issue.

All of the above can involve failure to follow procedures, since many procedures are aimed at heading off such errors. Dupont classifies violations in three main ways.

In a situational violation, he says, a mechanic concludes a job can't be completed without violating a procedure. This is often related to time pressures. It may not be repeated. The situation seems to justify the violation.

An exceptional violation occurs when there appears to be no other way to accomplish the task. Dupont offers the example of a manual calling for three people to be used at all times when moving an aircraft. If a mechanic is out sick, crewmates may decide to push the aircraft carefully using the only two people available.

A routine violation happens when a mechanic believes there is a better way to complete a task and sees no negative consequences to the ad hoc procedure, Dupont explains. It may start as a situational violation, but over time the informal procedure may become a norm.

If the mechanic's organization condones or tolerates the violation, it can move into a fourth class: the organizational violation. A classic



When the recovery operation lifted the nose of this British Airways 787, the downlock pin was found fitted not in its hole but in the apex pin bore next to it. This occurred after multiple checks to ensure the downlock pins were in place.



The FAA has a free, 45-minute training course, "The Buck Stops with Me," available at [FAA.gov](http://FAA.gov). Joy Finnegan image.

example, Dupont says, is May 25, 1979's crash of American Airlines Flight 191. The links leading to the accident, which killed all 271 on the plane and two on the ground, included failures by the jet's manufacturer, the FAA and the airline's management, engineering and maintenance departments, as well as the mechanics.

Safety proponents are refining efforts to reduce procedural non-compliance. The FAA has fielded a free, 45-minute training course, "The Buck Stops with

Me," aimed at "creating champions for rules-following," Johnson said. Several researchers are pursuing efforts to apply the safety gains of line-oriented safety audits on the flight deck to maintenance operations. Expanding requirements for operators to set up safety management systems may aid the effort by promoting the acceptance and use of human factors analysis to maintenance.

"There is no silver bullet for any of this," Baron said. "It's all about awareness." **AM**



# IT SYSTEMS FOR PARTS LOCATING AND TRACKING

James Careless



inding and tracking hard-to-find aircraft parts — and accessing support services to help with the acquisition and stocking process — is a constant challenge

for the global MRO industry. COVID-19 has only made the situation worse, by slowing down supply chains and the manufacturing/distribution of spare parts.

The good news: Web-based information technology (IT) systems are helping to ease this problem for MROs through online parts locating, purchasing, tracking, and deliveries. Here is a look at some of the players in this market, and how they are performing for clients during the current supply chain crunch.

### Four Key Players

There are a number of IT-based companies offering parts locating, tracking and sales on the web. Here are four of them that responded to Aviation Maintenance's requests for interviews.

Farsound offers a vast range of expendable parts across a multitude of company search engines. The company also provides purchasing/delivery services to MROs ranging from consignment, kitting, Kanban and ad hoc orders. All orders can be placed by Spec2000, Aeroexchange or via email.

"Having consignment at the customers location saves time with shipping," said Lee Kelsey, Farsound group sales director. "Parts are readily available, even if there are fluctuations in demand."

"Our kitting services save time for the operators and stores personnel," he added. "They don't have to book individual items in their store or transact them out. The kits are built to go straight to the operator on the shop floor, saving a lot of time and foot fall."

Farsound is developing an e-commerce platform, which is scheduled to go live in February 2022. Customers will be able to login to make orders, review their order histories, track items shipped and check on Farsound's 'live stock'.

ILS and its online ILS Marketplace makes it easy for MROs to search through its inventory of one billion-plus parts, and access the company's global services aimed at commercial, general aviation/ business aviation and defense/military customers. ILS also provides direct supply chain integration, a wide array of market intelligence solutions and real-time updates on parts availability and prices, even during the current COVID-induced supply chain crunch.



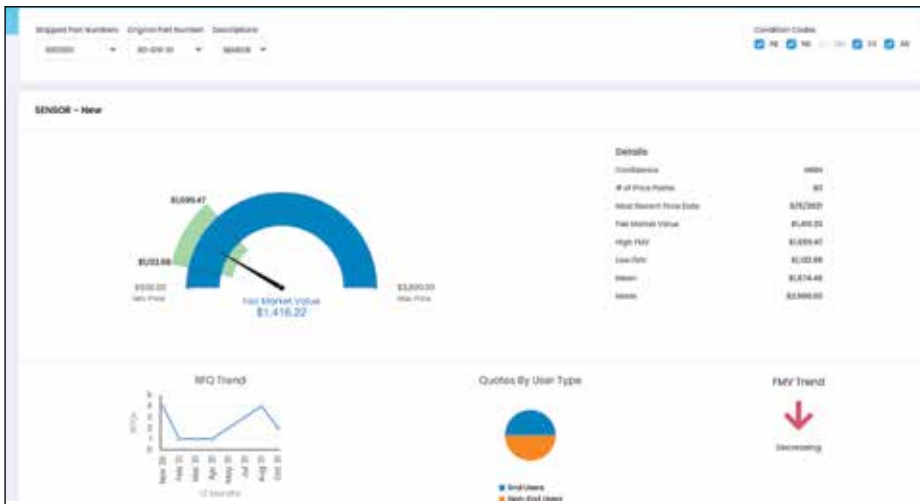
Farsound provides multiple purchasing/delivery services to MROs and is developing an e-commerce platform, which is scheduled to go live in February 2022. Farsound image.



ILS says their ILS Marketplace makes it easy for MROs to search through its inventory of one billion-plus parts.

| RFQ Number      | Received | Part Number                             | Company          | Items | Priority | Closing | Type | Source | Market Value | Status |
|-----------------|----------|---|------------------|-------|----------|---------|------|--------|--------------|--------|
| 43A220008029548 | Aug-20   | RD-2200, 0862, 300000-102, 400000-4C... | Rainco of Dallas | 7     | High     | Sep-20  | RFQ  | ILS    | \$2,000.00   | Open   |
| 43A220008029549 | Aug-20   | RD-2200, 300000-102, 410                | Rainco of Dallas | 8     | High     | Sep-20  | RFQ  | ILS    | \$2,000.00   | Open   |
| 43A220008029550 | Aug-20   | RD-2200, 300000-102, 410                | Rainco of Dallas | 8     | High     | Sep-20  | RFQ  | ILS    | \$2,000.00   | Open   |
| 43A220008029551 | Aug-20   | RD-2200, 300000-102, 410                | Rainco of Dallas | 8     | High     | Sep-20  | RFQ  | ILS    | \$2,000.00   | Open   |
| 43A220008029552 | Aug-20   | RD-2200, 300000-102, 410                | Rainco of Dallas | 8     | High     | Sep-20  | RFQ  | ILS    | \$2,000.00   | Open   |

ILS says their products ILS SalesEdge and ILS BuyersEdge can help improve sales/purchasing productivity at a time when team sizes are smaller.



ILS says the pandemic did not impact their ability to source and locate parts but says they have continued to enhance their products and services to keep pace. ILS images.

"While the pandemic did not impact our ability to source and/or locate parts, we have continued to enhance our products and services," said Eric-Jan (EJ) Schmidt, ILS' head of Global Marketing, "These enhancements include products and services to make our customers more efficient — such as our ILS Bridge providing real-time ILS Marketplace

integration for Quantum/CORRIDOR and other ERP customers — and to assist them in improving sales/purchasing productivity at a time when team sizes are smaller, using either our ILS SalesEdge or ILS BuyersEdge." ILS also gives its clients more ways to access supply chain market intelligence through its expanded FMV Intelligence, Aviation Data Warehouse access and large IPC Analyzer portfolio (airframes as well as engines) to help MROs and other customers make better buying and selling decisions.

"During COVID, we saw an increase in customer demand for 'parts sourcing optionality' -- i.e. if I cannot afford and/or timely source a new part/component, what USM or PMA alternatives would be available?" Schmidt noted. "Consequently ILS has developed expanded Intelligence for USM/PMA parts, benefitting MROs and other suppliers with better insights into available demand, supply, and quality levels."

STS Component Solutions provides a host of IT-driven supply chain solutions to airlines and MROs worldwide. These solutions include OEM parts distribution, repair management, AOG services, and warranty administration inventory valuation/analysis, as well as offering "Hard to Find" sourcing services. The company also provides integrated solutions that include reliability analysis and tracking, 3D printing, engineering services, and staffing solutions.

"STS Component Solutions provides cost-driven programs focused on the proper stocking and strategic placement of inventory, either on-site or geographically situated to eliminate the delays associated with parts shortage," said Tom Covella, group president of STS Component Solutions. "Additionally, our engineering services people are able to provide DER (Designated Engineering Representations) services in a very expedited manner eliminating potential delays from OEM approvals."

For those MROs needing more than parts and services, GlobalAir.com offers its customers access to an aviation business database with more than 550 maintenance, repair and operation companies included. It also contains a database of virtually every FBO in the United States. Many of these companies are partners or sponsors of GlobalAir.com.

According to Josh Coffman, this company's vice president of Content and SEO, "GlobalAir.com is a one-stop shop to find everything you need from an interior designer, an aircraft painter or to





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STS Component Solutions provides a host of IT-driven supply chain solutions to airlines and MROs worldwide. Shown here is a hose kit. STS image.

buy a new or used aircraft. The aviation community has counted on our site for a quarter of a century to find reputable MROs."

### COVID's Impact

Given the global pandemic's two-year stranglehold on the global supply chain, it made sense for Aviation Maintenance magazine to ask these companies about COVID's impact on their businesses — and their ability to source parts and services for clients.

Not surprisingly, the pandemic has gummed up the works.

At STS Component Solutions, "we have seen COVID impact delivery dates and lead-times throughout the industry," said Covella. "Lead times are being extended as the global market is being challenged by both material availability and labor resources. This is a new challenge that our industry is now facing, and we must adjust accordingly. At STS, we are constantly adjusting our inventory forecasting tools to accommodate for these new extended lead times, plus additional tools and KPIs to track 'on time' deliveries."

Locating scarce aircraft parts during COVID has not been easy for MROs and their suppliers. "The pandemic increased competition, forcing more MROs and other suppliers to find ways to lower the probability of supply chain related challenges," ILS' Schmidt said.

To help MROs cope, ILS came up with a number of creative options. For example, "we provided them with 'parts optionality' insights to help them work through the problem," said Schmidt. "Meanwhile, many customers experienced talent shortages and a need to make smarter decisions faster with less staff, increasing their demand for intelligence

that we included in our various solutions. These solutions can range from as simple as one-click on-demand requests for information, to more comprehensive AI/ML and RPA (Robot Process Automation) powered solutions that intelligently help prioritize responses to RFQs."

As for GlobalAir.com's take on COVID-19's impact on supply chains? "More business is being done remotely," Coffman replied. "More private aircraft are being acquired overseas and then brought here for maintenance. We are seeing some of our strongest traffic in our site's history. Now more than ever, aviation businesses need a strong online presence, and that's something that's been in the GlobalAir.com DNA since the mid-1990s."

### Offsetting the Shortages



Farsound has introduced engine-side vending machines at some client's locations. These machines allow parts for specific engines to be stored and delivered as needed. Farsound image.

One reason why supply chains dried up during the pandemic was due to customers cancelling their orders for parts, in an understandable bid to conserve

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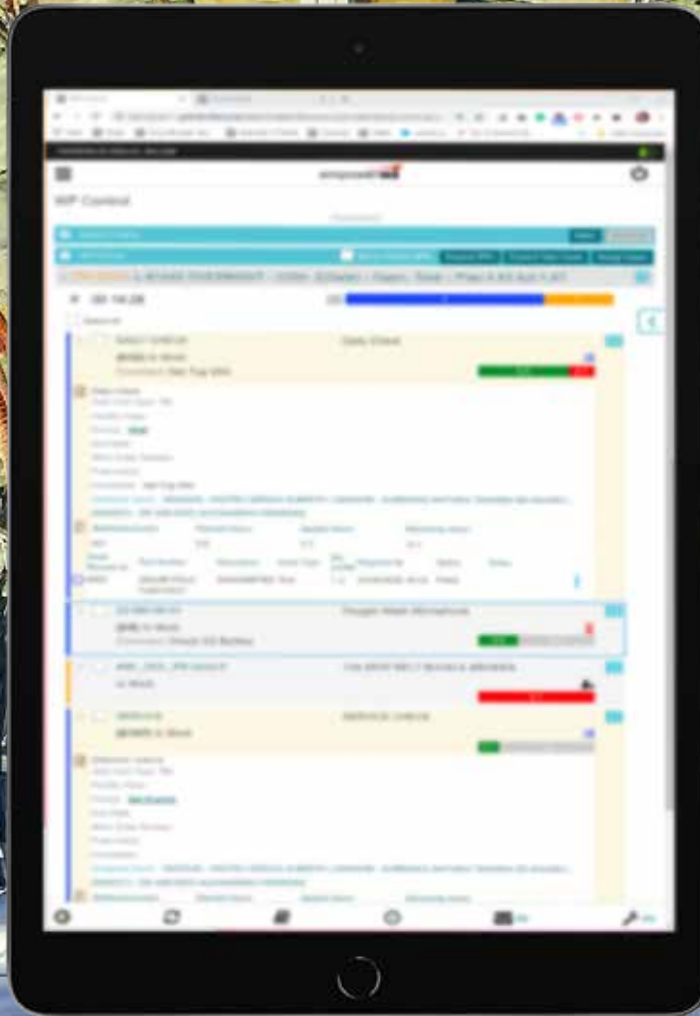
3rd Party  
MRO  
Integration

Data  
Connector  
on-the-cloud

Workforce  
Planning &  
Management

Billing &  
Invoicing

Predictive  
Analytics &  
Reporting



**empowermx**  
• sales@empowermx.com



STS offers inventory forecasting tools, 'Smart Stock' inventory programs, exchange programs and AOG devices to help their clients handle any situation. STS image.

part of their day-to-day locating and tracking process. To this end, "Farsound is trying to be fully integrated with our customers, building long term partnerships so we have an even better understanding of their requirements," said Kelsey. "This includes offering an e-commerce platform where they can see what we see in our system, providing MROs with total transparency. We have also introduced engine-side vending machines at their locations. These machines allow parts for specific engines to be stored and delivered as needed on site, again reducing time."

Meanwhile, ILS is committed to expanding its range of products and services for MROs in various ways. "Consistent with our vision, we will offer more enhanced decision analytics to MROs with data-driven intelligence, plus additional advanced aviation intelligence using AI/ML technology and other data sources," Schmidt said. "We will also drive more collaboration and compliance among marketplace customers to provide a trusted buying and selling experience, plus expand our ERP and add transaction integration with their systems as well as our marketplace, evolving ILS into a supply chain hub."

STS Component Solutions is also seeking ways to improve parts location, tracking and delivery to its MRO customers. To this end, "we are constantly changing and adapting our products and services to address the current challenges," said Covella. "We have spent many hours refining our data analytics and forecasting tools to make sure we have current market and demand data. Additionally, we have established integrated solution teams on site at our customers to focus on the largest 'pain points' they are currently experiencing."

"Our ability to establish on-site teams and integrate with our customers will lead to improved support levels, reduced parts shortages, improved reliability and higher dispatch reliability," he noted. "Right now, STS Project Teams are evaluating internal processes and identifying bottlenecks and cost savings opportunity by establishing kitting programs, exchange programs and strategic stocking programs."

Finally, GlobalAir.com is reviewing its portfolio of services, seeking ways and opportunities to help MROs. "From direct advertising to digital marketing, we offer an array of options to help aviation businesses fly above their competition — especially in these turbulent times," said Coffman.

The bottom line; IT-driven parts locating, tracking, and delivery companies are pulling out the stops to address the parts supply chain crunch for MROs. Although they can't solve the supply chain issue on their own, these companies are doing what they can to make the situation better. **AM**

cash. But this wasn't the case at Farsound. "During the global COVID pandemic we made a conscious decision not to cancel purchase orders on our main manufacturers and suppliers," said Kelsey. "We knew there would be a bounceback within the market and it would be better to have additional stock around us. We knew that turnaround time and service will be key in the uptick in the market."

"Holding stock of the right product is essential, providing a quick turnaround for MRO orders and ensuring that there are no issues," he observed. "The fact that we did this allows our MRO customers to focus on other issues of importance."

"With STS Component Solutions' inventory forecasting tools, 'Smart Stock' inventory programs, exchange programs and AOG devices we are able to address some of the challenges the industry is currently facing," added Covella. "Our ability to provide 'Additive Manufacturing' (3D printing) is also able to supplement current shortages in the global supply chain crisis."

## Making Things Better

As MROs come to rely more on IT-driven parts locating, tracking, and delivery, it only makes sense for them to know what the industry has in mind to improve and speed up the process.

Here's what these four players told us.

For Farsound, achieving success in easing MROs' parts procurement means becoming



STS says they are constantly adjusting their inventory forecasting tools to accommodate for new extended lead times due to the current supply chain challenges. An STS galley shown above. STS image.



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# TRAINING CHALLENGES

# IN THE NEW DIGITAL AGE



Lufthansa Technik Training image.

training. The mandate passed last December, part of a decades-long effort to bring maintenance training into the 21st Century, but has yet to be implemented.

## Brave New World

Companies are adopting new technologies for which trainees must prepare.

For instance, Safran contracted with Librestream to adopt its Onsite augmented reality platform for remote customer support. Safran Helicopter Engines first launched a remote assistance service called Expert Link in early 2018. The instant expert connection for technical diagnostics and preventive maintenance tasks through a live video and audio feed accounted over 1,000 visual assistance calls covering 40 countries per year.



Jasoren says technicians wearing smart glasses can receive instructions directly in their view with no need to interrupt their work and check the reference manual. Jasoren image.

Jasoren is also offering remote maintenance using augmented reality to provide remote workers with real-time, AR-based assistance through video calls with experts, shortening maintenance downtime while reducing travel expenses and errors, said the company. In training, it is more engaging and interactive with real-time remote guidance by experts, increasing the effectiveness of onboarding and training sessions

Similarly, aircraft painters with the Air Force 588th Aircraft Maintenance Support Squadron Corrosion Control shop, are using a virtual reality paint training allowing hands-on time in a controlled environment simulator to reinforce the skills learned in class.

Many have already deployed virtual

## Kathryn B. Creedy

# T

he fast-paced digital transformation of the aviation industry, coupled with the emergence of new propulsion technologies

is challenging the aviation maintenance training industry as regulators drag progress into the future of aviation maintenance.

While colleges, engine and airframe manufacturers and MROs such as Lufthansa Technik Training (LTT) and Air France Industries KLM Engineering & Maintenance (AFIKLM E&M) are adopting new training technologies such as Virtual Reality (VR) and Augmented Reality (AR), the critical aviation maintenance school ecosystem is being held back despite the fact FAA has been congressionally mandated to reform Part 147

maintenance trainers (VMTs) offering students 3D training scenarios through which to learn aircraft systems and troubleshooting. For instance, Airbus uses a VR headset, touchpads and infrared cameras enabling inspection and repair within the VR environment.

FlightSafety International (FSI) has Virtual Aircraft, an immersive 3D learning experience assisting students and instructors in exploring the aircraft as if they were out on the flight line. These true-to-life interactions with the aircraft's various components happen in real time. FSI indicated the technology results in higher retention, an increase in transferable skills and competency.

FSI also has Virtual Engine Trainers, a

simulation throughout the engine, allowing students to practice damage assessment and engine dispatchability. EASA has approved Virtual Engine Training as a method of assessment in up to 50 percent of practical engine training."

Through its LiveLearning delivery method, FSI offers clients a hybrid classroom – both in-center and remote, according to SVP Operations Brian Moore. "This allows for the same collaboration and discussion you would have in a traditional in-center course," he told **Aviation Maintenance**.

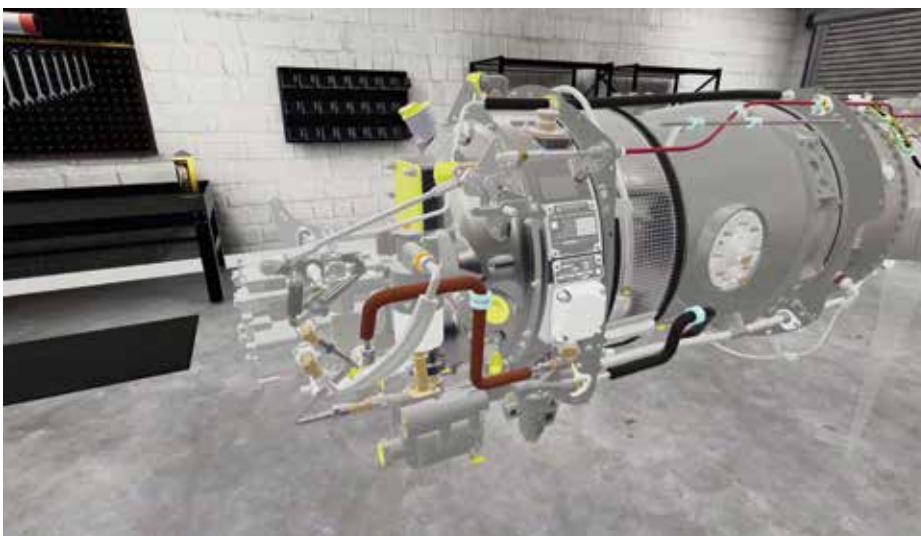
## Industry Wants High Tech Training Shifted to Training Environment

Industry has spoken with a single voice it wants better prepared aviation maintenance technicians. It signaled a requirement for super technicians able to work across avionics, airframe and engine disciplines. Finally, there is growing concern restrictive curricula will hamper integration of new propulsion technologies and advanced air mobility.

Aviation maintenance schools have been so hamstrung by highly prescriptive, antiquated training regulations that they spent almost two decades trying to change within the FAA. In frustration, Aviation Technical Education Council members developed modern curricula that would achieve the same competency outcomes and enable the adoption of new and innovative technologies. Congress used it to mandate the long-overdue FAA changes. It also allows for the adoption of new programming to accommodate emerging technologies and the expansion of the aviation maintenance training industry footprint to satellite facilities such as high schools and community colleges, necessary to address the mechanic shortage.

For instance, big data analysis and predictive maintenance has never been part of the FAA required curriculum and won't be part of the FAA mechanic certification standards (at least in the short term) when they are published. But, Crystal Maguire, ATEC executive director, said schools will have the flexibility to add content to their coursework once the new rule is published.

"We need to reform Part 147 regulations in order to give more academic freedom to teach students," Joel English, executive vice president at the Aviation Institute of Maintenance said. "There is evidence that the FAA is listening so schools are preparing for the day they are able to apply professional judgement and academic flexibility to our programs, which is severely limited today."



FlightSafety International is utilizing their Virtual Engine Trainers, shown in the images above, which allows students to practice damage assessment and engine dispatchability. FSI images.

real-time, interactive/animated models of Pratt & Whitney engines allowing manipulation of the engine and inner workings in any position or system grouping. Students can even change parts.

"X-ray and move functionality further enable students to view dynamic cross-sections into nearly every engine part," FSI wrote. "Borescope inspection training is also available with typical wear and tear





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Aircraft painters with the 588th Aircraft Maintenance Support Squadron Corrosion Control Shop learn how to use the virtual reality paint simulator at Robins Air Force Base, Georgia, this fall. The simulator allows the painters to use the training techniques taught in class and apply them virtually to reinforce what they have learned. U.S. Air Force photo by Joseph Mather.

The system is based on an hourly metric rather than proven competency but even that is complex.

“Though there is only one set of guidelines for part 147 schools, the individual Principal Maintenance Inspectors (PMIs) at the local FAA offices often interpret these rules differently. Though we have one standard curriculum taught at all 14 of our campuses, PMIs often interpret FAA rules differently and force our instructors to change the standard curriculum to fit a PMI’s own individual opinion. That means that we must adapt the standard curriculum differently at our different locations to meet the desires of the individual inspector. The FAA gives us a standard, we build one curriculum to meet that standard across the country, but the individual field officers make us change to meet their interpretation of the standard! It’s a challenge that will be overcome when the FAA allows us to apply our own professional judgement to the curriculum development process to accommodate the needs of the employers who hire graduates.

“Students will still be expected to attain the same outcome – passing the FAA certification exams to become a certificated A&P mechanic,” he continued. “But schools will have the ability to focus on what employers are requesting, and re-orient the instruction with some degree of academic freedom.”

There is more flexibility at the university level, English said because they go beyond the 1900-hour prescription and teach additional content

such as VR and other innovations. “The FAA neither regulates nor cares about this material,” he said.

To increase student preparedness, AIM includes an additional Capstone course, which is beyond the FAA’s 1,900 hours, and includes an adaptive learning platform and VR within that instruction.

## Covid Accelerates Innovation

“Covid definitely changed our training methods and sped up everything,” Zonda Feulner, Pratt & Whitney director of customer training, said. “We became more agile and creative. We quickly adapted our Engine Explorer Application from touch screen to using a mouse for remote learning and so we could pivot to AR and VR as needed because that is where a lot of our customers are going.”

FSI worked to get distance learning approved by regulatory authorities, resulting in increased efficiency and cost savings as such instruction moved online.

**Aviation Maintenance** previously reported L3Harris sees a 20 percent reduction in maintenance training costs with AR/VR/MR (mixed reality) training. More importantly for the aviation mechanic shortage, L3Harris increased student throughput fourfold with virtual training and projects it can achieve 30- to 50-percent reduction in training times with further enhancements to its learning management system.

Boeing also demonstrated the value of the technology with the same outcomes as working actual aircraft. Finally, GE found task performance time declined 10 percent and increased job satisfaction by 85 percent.

## The Evolution of AV MX Training

As aircraft and aviation maintenance professionals evolved so too has aviation maintenance training, said FlightSafety International SVP Operations Brian Moore.

“Our work with OEMs has allowed us to remain on the cutting edge of advances in aircraft,” he said. “We use a combination of real engines and components, and immersive training tools like our virtual engine and virtual walk-around to ensure each technician is highly skilled and able to troubleshoot effectively.”

The Covid changes are the latest in the evolution of maintenance training beyond classroom instruction, according to AFIKLM E&M’s Wanda

Manoth-Niemoller, commercial development manager, who noted AR use-cases are built in cooperation/partnership with other parties. Similarly, the company is studying cases incorporating combinations of Artificial Intelligence (AI) and big data in operations, as well as remote support.

AI is already the pilot training realm which can be applied in aviation maintenance training. The idea is to give students immediate data-based feedback on performance and identify areas where continued work is needed so students can master that work to ultimately gain competency. This immediate feedback is expected to improve competency and reduce training time. It is already using to track whether a trainee picks up the wrong tool and how often.

"We started off with our maintenance simulation training device on a laptop or desktop, with which we are able to save up to 50% training time on practical on the actual aircraft," Manoth-Niemoller told Aviation Maintenance. "With part 145 courses we are able to do 100% simulation. After the desktop simulation, we introduced VR in both part 145 as well as part 147 courses. The latest addition is AR, which we currently use to explain system behavior in the 777 and to do 100% of the practical for the engines on the 777 and the 787 in AR. The first business cases are now in development to introduce AR in the MRO operation. Also, in VR we are still developing such things as engine run up 2.0 and 360 VR which are made in cooperation with the schools, to use in part 66 training."

"In general, ours has evolved by inserting new technology into instructor-led, hands-on training," Feulner told Aviation Maintenance. "That goes hand in hand as engineering progressed. We started six years ago by creating our Engine Explorer Application for the GTF, V2500, and the JSF, displaying a 3D model students can manipulate to isolate different systems and search for different parts. This enhances the classroom portion and increases class participation. Once we created that foundation and built the 3D models, we switched over to VR training to test students. It allowed us to provide the support items, such as animation on how to do a specific task if they are having a tough time."

## Supplementing Online Training

Not all training can be done online,



Todd Lavender, 402nd Aircraft Maintenance Group corrosion control process manager, guides Glenn Cross, 588th Aircraft Maintenance Support Squadron aircraft painter, through the virtual reality simulator goggle setup. The aircraft painters are able to get hands-on painting experience for a C-5 or Global Hawk aircraft without going into a hangar to paint on the actual aircraft. U.S. Air Force photo by Joseph Mather.



Aircraft painters with the 588th Aircraft Maintenance Support Squadron Corrosion Control shop, are using a virtual reality paint training simulator to reinforce the skills they have learned in class at Robins Air Force Base, Georgia. Virtual paint training started at Robins this summer. U.S. Air Force photo by Joseph Mather.

however.

"I believe that nearly half of the part 147 program could be taught effectively online, but I have found that my students prefer face-to-face instruction," said English. "I've created a wide range of online simulators within many different academic situations, and my students want the real thing. We recognize students who want to become aircraft mechanics generally want to be in a hangar, with tools and equipment, alongside classmates and a seasoned instructor.

"I think that augmented and virtual realities are probably best for theoretical understanding of the anatomy of aircraft and for general familiarity of aircraft systems," said English. "As technologies get better, I'm sure there will be some manual processes that can be virtualized,



Lufthansa Technik Training Harald Schween says they believe Online Distance Learning (ODL) will be a game changer in the future education of workers. Lufthansa Technik Training image.

but I believe that AR and VR teach the mind, not necessarily the body. Something important happens when a student strikes an arc in a welding booth and not only sees the machinery respond but also smells the fumes, feels the heat and registers the resistance of the flame change when it touches metal that a computer cannot yet tell them; when they struggle to push an aircraft onto a scale and feel the bounce of the tires moving into position, they are learning something that an online simulation won't tell them. I believe becoming an aircraft mechanic is a process of tactile engagement as much as theoretical learning. The subtleties of work in an aircraft hangar and the physical feedback that tools and machines give the budding mechanic just can't be efficiently replicated on an iPhone or in an Oculus headset. That simple, satisfying ring of a ratchet, singing like a stainless-steel cricket in one's hand, speaks to a mechanic. Entering a username and trying to remember a password is not the mechanic's language."

Even so, there is no question online learning is here to stay.

"We see Online Distance Learning (ODL) as a game changer in future education," Lufthansa Technik Training head of sales, key account management & marketing Harald Schween told **Aviation Maintenance**. "ODL has become an important part of our maintenance training

portfolio. And, beyond online maintenance training, we expect blended-learning methodologies to become more relevant in the industry such as a combination of modern e-learning media with classroom and online training sessions."

For LTT, it's all about aligning its methods and tools to the requirements of customers. "We are convinced that VR, beside other digital solutions, will play a some role in future maintenance training," said Schween. "With VR we can give the trainees a better understanding of the complexity of an aircraft and can give them the chance to (virtually) touch components of an airplane. Through VR technologies we can show how the aircraft looks and we may use VR to complement deeper level maintenance training. Furthermore, we may have the possibility to bring practical elements into the classroom virtually to decrease the amount of physical practical training days at the aircraft."

Schween sees little progress at EASA to adopt new learning methods into regulations (Part-147, Part-66). "Hence, there are no formal benefits, such as credits to a EASA Part-66 CAT A or B program, through the application of eLearning, digital media or VR. On the other hand, the regulators have recently incorporated distance learning methodologies, such as video conferencing, into maintenance training

requirements. This has been done in a very flexible and industry-oriented manner. We strongly believe this positive experience and fruitful collaboration between industry partners and the regulators will be continued for the implementation of digital tools and solutions in the future.

"The transition from 'traditional' classroom training to new learning methodologies changes teaching significantly," he continued. "For example, instead of instructor-led lectures, the instructor becomes more a coach, guiding them throughout their learning path and experience. Instructors and trainees have to deal with new tools and methodologies such as handling of digital media and tools within a modern blended learning environment and we strongly believe in the benefit of 'blending' traditional and digital learning methodologies."

## Much to be Done

Even as industry continues to adopt new training technologies, the fact remains there is much to be done to bring the entire aviation maintenance training ecosystem to the same level. With part 147 reform in the United States and similar efforts on the international front, there will come a time when that happens, but it can't come fast enough given the speed with which different facets of the industry are moving. **AM**

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This large MRO hangar for Turkish Technic at the new Istanbul International Airport has generated considerable interest in Rubb Buildings. Rubb Buildings image.

# HANGARS AND HANGAR DOORS FROM SIMPLICITY TO ARCHITECTURAL MASTERPIECES

Ian Harbison



of COVID. However, there has been strong demand from the military and for the company's non-aviation industrial doors, used in buildings such as fire and ambulance stations and railway and metro depots.

A recent military contract was for Calidus in Abu Dhabi, which has developed the B-240 light attack aircraft, 24 of which have been ordered by the United Arab Emirates armed forces. These are being prepared in a new Flight Preparation and a Flight Assembly facility at Al Ain International Airport facility that was completed in 2020. This features two hangars, each with a set of Esavian Type 126 sliding doors measuring 30m wide by 5.6m high and fully clad with insulated flat sandwich panel cladding. The doors have six leaves that are electrically operated, with three sliding to each side of the hangar.

One bright spot has been new maintenance facilities for business aviation, which has experienced an upturn as the wealthy have looked for alternatives to commercial airlines during the pandemic.

Another 2020 project was to supply and install three sets of Esavian Type 126 doors for a 20,900m<sup>2</sup> Customer Support Service Centre for Gulfstream Aerospace Corporation at Farnborough Airport in the UK. The new facility can easily accommodate 13 large-cabin aircraft and offers maintenance, repair and overhaul services, as well as interior refurbishments and aftermarket modifications. Each of the three door consists of four door leaves, each 16.98m wide, to close off the clear opening of 67.4m wide by 9.25 m high. Each leaf, which is fitted with a continuous band of double-glazed windows at eye level, can move independently of each within the opening to allow multiple aircraft movements in and out of the hangars.

Currently, the company is supplying doors to Execujet's



Jewers Esavian Type 126 doors are fitted to the Gulfstream Aerospace Corporation Customer Support Service Centre at Farnborough Airport in the UK. Jewers Doors image.



Over the years, hangars have developed from large sheds to architectural masterpieces, the latter being driven by state owned airlines wanting a statement building at the country's international airport in the capital city and by the Airbus A380, simply through the building having to accommodate such a large aircraft.

That trend has now reversed, with increasing emphasis on simpler designs and concern for the environment, as can be seen by the activities of some of the industry's major players.

## Jewers Doors

Jonathan Jewers, director at Jewers Doors, says the market for commercial MRO hangars has 'fallen off a cliff' as a result

prestigious new hangar at Dubai South, also a further nine sets of Esavian Type 126 doors for the Turkmenistan Presidential Code C (narrowbody) and Code F (general aviation) hangars at Ashgabat Airport.

Jewers says he has noticed some promising movement in the market recently, with tenders for new hangars in Europe and Asia but also for the refurbishment of existing facilities.

Some of the new hangar projects may benefit from a change in regulations that does away with the requirement for a foam system for fire suppression if they are less than 4,500m<sup>2</sup>. Another notable design trend is a new emphasis to incorporate sustainability and reduced life-cycle operating costs, he adds, although some are calling for semi-permanent fabric structures as opposed to conventional hangar designs, although a part of this is

may be to show the building as equipment on the books, rather than an asset. Other trends include rainwater harvesting, solar panels on the roof and airtight door seals and improved thermal insulation to retain heat better.

His own company is no exception. It moved into a new purpose-built facility in June this year, with 4,245m<sup>2</sup> of factory space and a 1,115m<sup>2</sup> headquarters building. The new facility is highly insulated with energy efficient heating and cooling systems in both the factory and offices. The offices have a heat recovery system which maintains fresh air around the building while minimising heat loss. There are over 200m<sup>2</sup> of photovoltaic panels on the roof capable of generating over 42kW of power and with plenty of space to expand in the future. Excess electricity can be sold back into the National Grid. Low energy sensor controlled LED lights are fitted throughout factory — there are no light switches. Also, there are 8 EV charging points for employees in anticipation of the uptake in electric and hybrid vehicles and with provision to easily increase this number in the future.

## Buildair

Felipe Cano, sales director at Buildair is also very aware of the trends towards sustainability and fabric buildings.

The Spanish company specializes in inflatable hangars, formed by linking together identical inflated tubes made from fire retardant PVC-covered fabric. These are kept constantly inflated at a relatively low pressure of 20-30mb by two independent electric motors. The company has now improved the design to retain that pressure, which it calls AIRTIGHT, which means the motors are only required when the Automatic Control System detects a pressure drop. The system also performs real-time tracking of wind speed and fire detection, with alerts being sent to a computer or smartphone. To further reduce energy needs, the motors can be powered by batteries charged by solar panels if required.

The hangars use high-resistance anchorage systems instead of traditional foundation works, enabling them to be relocated if required.

A recent project, delivered in May this year, was a hangar in Hyderabad, India, for GMR Aero Technic. The building, designed for a single Airbus A320 Family or Boeing 737, measures 62m long with a 45m clear width, giving 2,800m<sup>2</sup> of useful space, without any interior columns. The 18m



In May this year, GMR Aero Technic in Hyderabad, India, took delivery of this 45m wide Buildair hangar. Buildair image.



Buildair's latest project is a hangar for The Helicopter Company of Saudi Arabia in Jeddah. Buildair image.

clear height allows the aircraft to be jacked for undercarriage removal and testing. It is fitted with an inflatable door.

Cano says India is set to become a major market as the government recently reduced the tax level on MRO work. Airlines are expected to bring their aircraft back home as a result, so there could be an urgent need for extra hangar space. The Hyderabad hangar was delivered with a lead time of just 3.5 months. He points that the door is important, as FAA and EASA make it a mandatory requirement in approving maintenance facilities, and Indian MROs may want to follow that route in expanding their customer base.

Back home, the company delivered two buildings to Lleida-Alguaire International Airport in Catalunya. This is a major location for aircraft storage and disassembly. The shelters, one measuring 25m wide, the other 20m. They are used to maintain small aircraft and pilot training aircraft.

The latest project, using AIRTIGHT technology and delivered in August, is a hangar for The Helicopter Company of Saudi Arabia in Jeddah. It has a length of 46m and a clear width of 20m, giving a useful area of 920 m<sup>2</sup>, and 10m clear height.

Jeddah is also the location of another Buildair hangar, this time at the opposite end of the size scale. Delivered in 2019 to Saudia Aerospace Engineering Industries (SAEI), a subsidiary of Saudia Airlines, it has a length of 80m and 75m clear width, giving a 6,000 m<sup>2</sup> covered area, while the 26m interior height allows an Airbus A330 or Boeing 777-200 ER to be jacked. It is the world's largest inflatable building.

Away from aviation, he is seeing increasing interest from the offshore wind farm industry. Being able to quickly construct a temporary facility at a nearby coastal location is a distinct advantage, whether for construction or repair and overhaul — a 25m wide shelter can be



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The world's largest inflatable building — a 75m wide hangar supplied by Buildair for Saudia Aerospace Engineering Industries in Jeddah. Buildair image.

packed into a single 20ft ISO container and erected in six hours. That also has attractions for disaster relief operations.

## Rubb Buildings

Ryan Clarke, sales executive at Rubb Buildings, says there was a shortage of hangar space for maintenance before the pandemic struck. As the situation gets back to normal, the demand will only increase further, which means unconventional structures will have an advantage if they can offer shorter lead times. His company uses a steel structure clad with high-strength, heavyweight coated architectural membranes from Serge Ferrari, combined with Rubb's own Thermohall cladding for insulation. This means a narrowbody hangar can be designed and built in six-eight months.

The latest project, commissioned in September, is located in the Bro

Tathan Business Park in Wales. This new development sits on the edge of the former RAF St Athan base and is designed to attract MRO organizations by having direct runway access. The hangar was ordered by the Welsh Government and is intended to be used by new arrivals while their own facility is being constructed.

With a length and width of 50m and an apex height of 18.5m, it can accommodate a single Airbus A320 Family or Boeing 737 aircraft. The structure includes 150mm Thermohall cladding and an Assa Abloy Megadoor vertical lifting fabric door with a clear width of 42m and overall clear height of 13.5m (Megadoor is Rubb's preferred supplier for vertical doors, Jewers for sliding doors, notes Clarke). The hangar also features a 500 lux LED lighting system, electric radiant heating, and a full HVAC system.

A previous project, in 2019, was a

large MRO hangar for Turkish Technic at the new Istanbul International Airport. Measuring 82.3m long by 87.5m wide and a height of 9.8m, it has 50mm Thermohall cladding, as temperatures are higher than at Bro Tathan, and a 71.9m by 19.8m Megadoor vertical door. The size of the hangar meant that 12,000m<sup>2</sup> of Thermohall cladding and 32,000m<sup>2</sup> of Preconstraint 412 and Preconstraint 832 fabric from Serge Ferrari were needed. The hangar is a temporary structure — when the main MRO facility is completed, it will be dismantled and moved to another airport.

Rubb Buildings is part of Rubb Industries, which helped with the installation but the project involved Rubb UK in the early sales process and securing the contract, Rubb Poland produced the Thermohall cladding, Rubb Norway provided the advanced Tekla program modeling and Rubb USA engineered and oversaw the project.

The project generated a lot of interest says Clarke, and raised Rubb's profile in the market. One result was a contract awarded in June to build an A380 capable hangar, measuring 300ft by 300ft and 40ft high, using a 10-span hot-dip galvanized steel frame. This will be equipped with a five panel vertical lift Megadoor system with pivoting mullions. There will also be a 12ft x 12ft electrically operated roller shutter door and four 3ft x 7ft pedestrian doors fitted with panic hardware for emergency stops and vision windows.

The customer and location have not been disclosed.

Closer to home, the company last year added a third bay alongside a two bay hangar at London Gatwick for easyJet. Although the extra bay could have been simply added to the existing building, the lay of the land meant there was a 10m gap, so walkways were installed to provide easy access.

As mentioned, Rubb is part of Rubb Industries AS, which operates in a number of industry sectors. Drawing on that experience, it was able to come up with an innovative scheme for aviation — the leasing of buildings. In this case, it was a 25m x 24m hangar which was supplied to a helicopter company for six months while it carried out a project. It will then be dismantled ready for the next customer.

Clarke comments that the demand for new hangars is coming from the Middle East and Central Europe, especially for A350/777 size facilities but there is also interest, for the first time, in paint shops, helped by improved door seals. As for



This A380 capable hangar, measuring 300ft by 300ft and 40ft high, is being supplied by Rubb Buildings to an undisclosed customer at an undisclosed location. Rubb Buildings image.



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sustainability, he says all the PVC and steel can be recycled.

## Champion Door

Pekka Hosio, CEO and founder of Champion Door in Finland, says his company's products are completely recyclable, being constructed of fabric covers over an aluminium and steel structure with one or two insulation layers depending on customer choice and their climatic conditions.

At the moment, he is seeing greatest demand from the military market, for new and refurbished hangars ranging size from helicopters through fighters to transport aircraft, although Eastern Europe has seen an increasing number of companies purchasing their own aircraft as a way of avoiding the complications of reduced

airfield was the opening in May this year of a maintenance hangar for Hong Kong-based Metrojet at Clark in the Philippines. The building is 110m wide by 63m deep, with over 7,100m<sup>2</sup> of floor space, and 21.5m high. Five vertical lift Champion doors, each independently movable, cover a clear space of 100m x 16m. The hangar can accommodate up to 10 long range business jets such as Airbus Corporate Jets and Boeing Business Jets, while a 2500m<sup>2</sup> two-storey annex building at the rear of the hangar with workshops, stores, staff and customer offices and lounges with available space for a dedicated Fixed-Base Operator (FBO). There is 11,000m<sup>2</sup> of apron space in front of the hangar with an exclusive private taxiway. The facility, with the doors, has been designed to the highest international standards including typhoon


that opened in February 2020 at JOB AIR Technic MRO hangar in Ostrava, Czech Republic.

In 2019, it worked with French construction company MAS BTP on a hangar extension at Airbus in Toulouse. The extension at the front of an existing Beluga ST hangar used doors measuring 65m in width and with a maximum height of 24m, enabling the hangar to be used by the larger Beluga XL.

Talking of standards, the company has been involved for four years in helping to update the UFGS-08 34 16.20 specification of the US Naval Facilities Engineering Systems Command (NAVFAC). These are regarded as the world's most detailed and strictest guide for fabric fold-up doors. The revised specification now includes technology that has been used for a long time by Champion Door in all its doors, in aviation, shipbuilding and industrial applications.

Hosio points out that fabric lift doors work well in hot conditions, where the tightness of the fabric keeps heat, sand and dust away from the building and from disturbing work. Unlike traditional lift door solutions, no dust or dirt can accumulate on the ends of the Champion Door's door side rails or door joints, which could, in the worst case, stop the door from working.

They are also suited to cold conditions — the company is Finnish, after all — where traditional door solutions may have difficulties. Fabric doors do not freeze or jam, even if there is ice and snow around while heat stays inside.

A good example is from Widerøe, the Norwegian regional airline, that has hangars at Kirkenes and Vadsø. These have been equipped with three-piece NK4 Warm and NK2 doors since 2005 and 2011 respectively. Both airports are around 400km north of the Arctic Circle and winter often brings sudden large temperature drops, huge masses of snow and strong, violent winds. The most important job for the doors, which are opened several times a day, all year round, is to keep the snow and wind out but they must also keep the hangar warm for personnel and the aircraft protected from the weather. This is particularly important if there is a need for urgent maintenance or repairs, which can be carried out at Kirkenes — Vadsø is for parking only. Kirkenes also carries out deicing operations in the hangar, so those doors may be used more often. 



This maintenance hangar for Hong Kong-based Metrojet at Clark in the Philippines has five vertical lift Champion doors. Champion Door image.



Champion doors on the JOB AIR Technic hangar in Ostrava, Czech Republic. Champion Door image.

airline activity and rapidly changing schedules. As a consequence, they also need a hangar.

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and seismic loadings.

Closer to home, the company supplied its NK4 Warm doors, the highest thermal rating, to a new two-bay narrowbody



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## SMS Part 7: Using the SMS Hazard Log to Support Change Management

In our last article we began looking at the high-level strategies for selecting mitigations, or risk controls, to reduce the risks associated with aviation safety hazards. This month we will examine how to record Safety Management System (SMS) data in a hazard log, as well as one of the less-obvious benefits of an effective SMS: the potential to use the safety risk management records to support effective change management.

**Aviation Maintenance Magazine** has been publishing a series of articles explaining how to establish and use a safety risk management (SRM) system to identify aviation safety hazards and assess the associated risk. SRM is one of the four key components of a complete Safety Management System (SMS). This (seventh) article assumes that you have some familiarity with the basic concepts of SMS that were covered in those first six articles. If you do not, then we recommend that you go back and read the past six articles (you can find all six at [www.avm-mag.com](http://www.avm-mag.com)).

In the past articles on SMS, we have discussed how to identify a hazard, how to assign values to the hazard correlating to likelihood of harm and consequence of such harm, how to assess the total risk posed by the hazard, and how to mitigate the risk. These are all part of the SRM component of an SMS. A robust SRM allows the user to assess the risks associated with hazards, and rank those risks, with the aim to focus limited resources on the hazards that pose the greatest risk, first. Once the hazards with the highest levels risks have been mitigated, then resources can be devoted to those with lower-level risks. This approach permits a risk-based



A safety risk management (SRM) system is one of the four key components of a complete Safety Management System (SMS).

approach to the development of a safety system, but it also encourages continuous evolution of the system that is used to manage safety.

SMS does more than merely help allocate limited resources. It also helps to document safety decisions, and it offers an opportunity to use those records to support elements of your safety system, including effective change management.

### Recording the Results of Your SRM

One of the basic elements of SMS is documentation, and thus the system should document each of the four components of SMS, including SRM. The SRM documentation can be divided into two sets of records: (a) the records that describe the SRM processes, like the SMS manual, and (b) the records that are created as outputs of the SRM, like a hazard log. Note that this does not include the myriad records that are part of other systems, which nonetheless may be analyzed in the context of the SRM processes (like your existing component maintenance manuals used to support repair processes).

The hazard log is simply a compilation of the hazards that have been identified through the SMS, and the records concerning the way that

each hazard was processed, including risk assessment data, identified/implemented mitigations, and the actual results of those mitigations.

I have a list of about 20 categories of fields that I recommend for capturing information in a complete hazard log. I don't have enough space in this column to provide a full analysis of all fields, but a list of my preferred starting fields is being published as part of the scalability appendix in the next update to the SM-0001 Standard (expected late 2021). Pull up that standard if you want to see what I recommend. So I will just identify a few key fields that ought to be in your hazard log.

First you should identify the hazard and the details associated with it (this reflects multiple fields). Details can include information like scope: for example, if this hazard is only analyzed in a particular context, then that context should be identified. A missed-inspection hazard that arises in one repair, and also appears to arise in another repair, might have different consequences in each repair and therefore the hazards should be assessed as two different hazards, each with a different scope, because each has a different consequence.

As another example, proper calibration for ovens used to relieve hydrogen embrittlement is far more important than proper calibration for ovens in the break room (and the risk assessment for each will be different).

After identifying the hazard, you should record the risk assessment results. This typically means recording the likelihood, consequence/severity, and total risk (at a minimum). I typically like to record the risk assessment as it exists in at least four states:

- Risk assessment with no mitigations [as if there was no quality system at all – most existing businesses will already have some risk process controls in place before the SMS is created – such a processes required by the regulations – and it is important to recognize that those processes already mitigate risk and without them the risk would be worse];
- Risk assessment with current (existing) mitigations [recognizing that there may be risk controls — or mitigations — already in place in an existing system; if the risks shown between first and second assessment are the same then this might be an indication that the current mitigations are not having any appreciable affect, or it might suggest that your risk assessment categories are too broad to capture differences in risk level];
- Risk assessment with proposed (new) mitigations [before implementation, to identify anticipated results; once again, if the risk assessment shows that the risk level is the same in the second and third assessments, then this could suggest that either the mitigation is inadequate, or the risk-measurement-scale is insufficiently precise];
- Risk assessment with new mitigations [following implementation, to identify actual results and compare them to anticipated results; if the achieved risk level does not match the anticipated risk level, then this could be a signal that the mitigation is inadequate or improperly implemented; note that the goal is typically to reduce the risk to an acceptable level, so there remains the possibility of residual risk].

Each of these risk assessments would be compared to the business' safety goals to determine when the risks of the associated hazard are satisfactorily mitigated. Obviously, the risk assessments may be performed (and recorded) at different times to reflect the process flow of the business' SMS.

The mitigations should be listed in the hazard log as well. I like to recommend that the hazard log be established as a relational database. This allows one hazard to have more than one mitigation (recognizing that this is often the case in modern real-world quality systems) but it also allows a single mitigation to address more than one hazard. For example, a decision to purchase an alternative PMA part to support a particular repair might have been intended to mitigate the hazard of short supply from the original source, but if the PMA part also incorporates modifications designed to improve reliability, then it might also be claimed as a mitigation to a reliability hazard identified in the next higher assembly. In such a case the mitigation might reasonably be associated with both

hazards. The importance of this arrangement in the hazard log will become clearer as we discuss the Change Management topic, below.

## SRM and Change Management

I've spoken to many quality professionals who find the relationship between SMS and change management to be confusing. One of the reasons that this is confusing is because at the beginning of the SMS program, before a hazard log has been established, there appears to be no difference between a change management analysis and a typical SRM analysis. In each case you are identifying hazards and then analyzing them. This is frustrating to professionals who are seeking a systems-based approach to change management.

Simply applying SRM to the change generates multiple potential dangers within the system — there is a danger that the analysis will fail to predict a hazard associated with the proposed change. There is also a danger that the proposed change will lead to unintended consequences by impacting a mitigation that is associated with an unrelated hazard.

Luckily, a robust SMS can help to mitigate these two dangers; because as the hazard log is populated with data, it will become an important change management tool.

Remember that we are recording hazards, and their details, in the hazard log. If you are following my advice, then each hazard that needed to be mitigated is linked to one or more mitigations in the hazard log (e.g. through a relational database link). These are the mitigations that successfully reduce the risk to an acceptable level. If you look back at the recent article on risk mitigation selection strategies (<https://www.avm-mag.com/sms-part-6-strategies-for-identifying-and-selecting-risk-controls/>), you'll see that there are multiple types of risk process controls and multiple

strategies for implementing those risk process controls. These can range from written procedures, to training, to system design that drives safe behaviors. In each case, if you catalog those risk mitigations in your hazard log and link each one with the hazard(s) that it mitigates, then this will allow you to examine whether a change will impact risk mitigations (for example, a manual change that modifies the language of a procedure) and then you can identify the linked hazards. You can also examine how the mitigation affects those hazards. This permits you to begin your change management process by relying on analysis that has already been performed within the SMS. If you will change a risk mitigation, then examination of its connections in the hazard log allows you to identify the most likely consequences of that change (including the identification of unintended consequences).

This doesn't take the place of a process that independently identifies likely hazards and performs safety assessment on each one, but it does provide a starting point, so that previously accomplished analysis can be reused, and so that known hazards can be assessed in the context of the change using the existing system information as a guide.

As the hazard log becomes increasingly more mature, it will capture the collected analyses of the past in a way that can directly support a systems-based approach to change management, allowing the safety department to identify likely consequences, and to develop new mitigations to ensure that previously identified hazards continue to be properly mitigated, particularly after a change. **AVM**

*Want to learn more? We have been teaching classes on SMS elements, and we have advised aviation companies in multiple sectors on the development of SMS processes and systems. Contact us if we can help you with your SMS questions.*

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# THE MODERN AEROSPACE WORK PLATFORM: OPTIONS AND REQUIREMENTS



Ken Wasiuta

**E**quipping maintenance personnel in the aerospace industry with the proper tools necessary to perform their required work safely and efficiently is critical. One of the most crucial tools that maintenance personnel need is a quality work platform that gets them very close to where they need to work. In the aerospace industry, this is often easier said than done. Thus, a reliable work platform is a key element that can sometimes be overlooked. Furthermore, the design and fabrication of work platforms involves many considerations and potential customizations that may not always be top of mind. Certainly, as the MRO industry has evolved, so have the demands

on aerospace maintenance personnel as they pertain to the development and utilization of a work platform.

Work platforms are nothing new. Simple work platforms have been utilized in the industry for years. However, as technology has improved, so have the options available on work platforms. This evolution has led to the need for custom fabricators and designers to stay ahead of the demand and evolve along with the industry. There are features in today's work platforms that simply weren't available or even considered 20 years ago. What's important to the industry today is much more advanced than ever before. In addition to more safety considerations, today's aerospace maintenance worker prefers a work platform

with improved mobility, configurability, worker access, utility availability and specific material selection. These elements all must be top of mind for designers and fabricators in order to deliver an efficient, effective platform.

Safety is typically the number one priority for maintenance workers. Therefore, first and foremost, a work platform must follow OSHA guidelines. Unfortunately, there are still work platforms in use today that do not meet the most current guidelines. This can be due to a variety of different reasons. For example, perhaps there are not sufficient handrails, or the incline on a certain set of stairs doesn't satisfy the OSHA's requirements concerning how steep they can be. There are countless elements that OSHA outlines pertaining to



the safety of work platforms and designers and fabricators need to be confident that the equipment they are ultimately delivering meets these standards. Every single facet of the work platform must meet the guidelines. Not a single element can be overlooked.

Load rating is certainly one of the most important safety elements that must be considered when designing a reliable work platform. This starts with the designer having a good understanding of how the platform will be used, the number of people who might be on it at one time and any equipment that might be used on it, and then designing the work platform accordingly.

A development that has continued to gain momentum is the demand for non-slip walking surfaces. The safety implications associated with ensuring that walking surfaces have this characteristic cannot be overstated. To be clear, striving toward a non-slip walking surface is not new, but the technology has most certainly evolved over the years. Tread plate has been around for quite some time. This was one of the most common ways that this challenge was tackled. Tread plate, however, didn't always protect against slips due to moisture or chemicals on the walking surface. There are a multitude of reasons why a work platform may get wet or oily. It could just be due to the nature of the work being done. Unfortunately, when these traditional surfaces get wet or oily, they could become extremely slippery. At that point, the non-slip aspects of the surface may as well not exist.

Today, there are options in the form of slip-resistant roll-on, spray-on and brush-on coatings. These have been known to perform better when moisture or oily substances are present. Additionally, there has been rising demand for using slip resistant engineered wood installed over corrugated metal decking. One particularly innovative solution involves the application of a metallic grit substrate directly onto a metal walking surface. It is an interesting process to apply this technology. A thermal spray containing the grit material is applied at a very high temperature to the walking surface material. When it cools, the non-slip characteristics develop. The most attractive element of this technology is its longevity. Unlike other grit materials added to surfaces that wear down and become less effective over time, this process surface holds up very well, even when exposed to moisture or oils.

Work platforms also cannot contain any components that might present hazards in the environment where they are used. For instance, if the platform will be used in an environment with explosive gases, such as in a paint booth, careful attention must be paid to the lights and other electrical devices on the platform that might create a spark and



Improved mobility, configurability, access and utility availability are key elements of work platforms. WB Industries image.

possibly an explosion.

Additionally, attention must be given to the material selected to build the platform. Depending on the environment the platform will be used in, only certain materials may be permitted. For example, chemicals may be present in a certain environment that will have a negative effect on a certain type of material. This degradation can ultimately compromise the integrity of the structure. Material selection also comes into play for platforms used in certain parts of the world, as locations near the ocean, which have high concentrations of salt in the air, or areas that are especially humid, can affect how a material performs over time.

Other elements that designers need to be aware of is the need for fall-restraint tie-off points for the various maintenance activities that will inevitably be performed that require this extra safety. Smaller but still critical features include the padding added to various points on the platform in the form of foam or rubber safeguards. These precautions are needed to protect both the items being maintained and the people maintaining them.

In addition to being safe, work platforms must be as practical and useful as the fabricators can possibly make them. This starts with mobility. In the past, even with mounted casters, work platforms were extremely difficult to move around. With improved technology, this is no longer the case. The caster industry has learned that by installing multiple wheels on a single caster, friction is greatly reduced, especially when getting a stationary caster rolling. Through these and other improvements, a single maintenance worker can more easily move by themselves what used to take multiple people to move.

In addition to easier movement, the industry today is looking for work platforms to be nimble. The platform must be designed to

perform a variety of different tasks. Thus, the platform must have a robust configurability. It must be operable at different heights and accommodate any kind of unusual situation where a maintenance worker must get to a hard-to-reach area. This doesn't just mean vertically, but horizontally as well. Slider decks and removable panels can be installed to achieve this goal.

Finally, there are many more options available in terms of utilities that can come with today's maintenance platform, and fabricators need to be aware of the various demands that may come their way. Requirements may come in the form of hydraulic, pneumatic, compressed air or vacuum systems needing to be installed on the platforms. Are the electrical requirements going to be single, multiphase or low voltage? All could be a possibility. In the modern age of communication, data requirements must be considered. Enough data cables will need to be run to accommodate the number of computer workstations required.

Work platforms are anything but simple today and it's important for fabricators and designers alike to keep a pulse on the growing demands from end-users in terms of safety and use. **AM**

*Ken Wasiuta is the vice president of WB Industries, a custom metal fabrication company that builds and installs product solutions designed to improve safety, efficiency and performance. Many of WB Industries' products are integral in local, national and international manufacturing facilities, military bases, aircraft carriers, public areas and within the country's infrastructure. WB Industries applies customer specific requirements to its projects and work to several industry standards including NASA, Boeing, Lockheed Martin, AMS, AISC, IBC, ASTM and MIL specs.*

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