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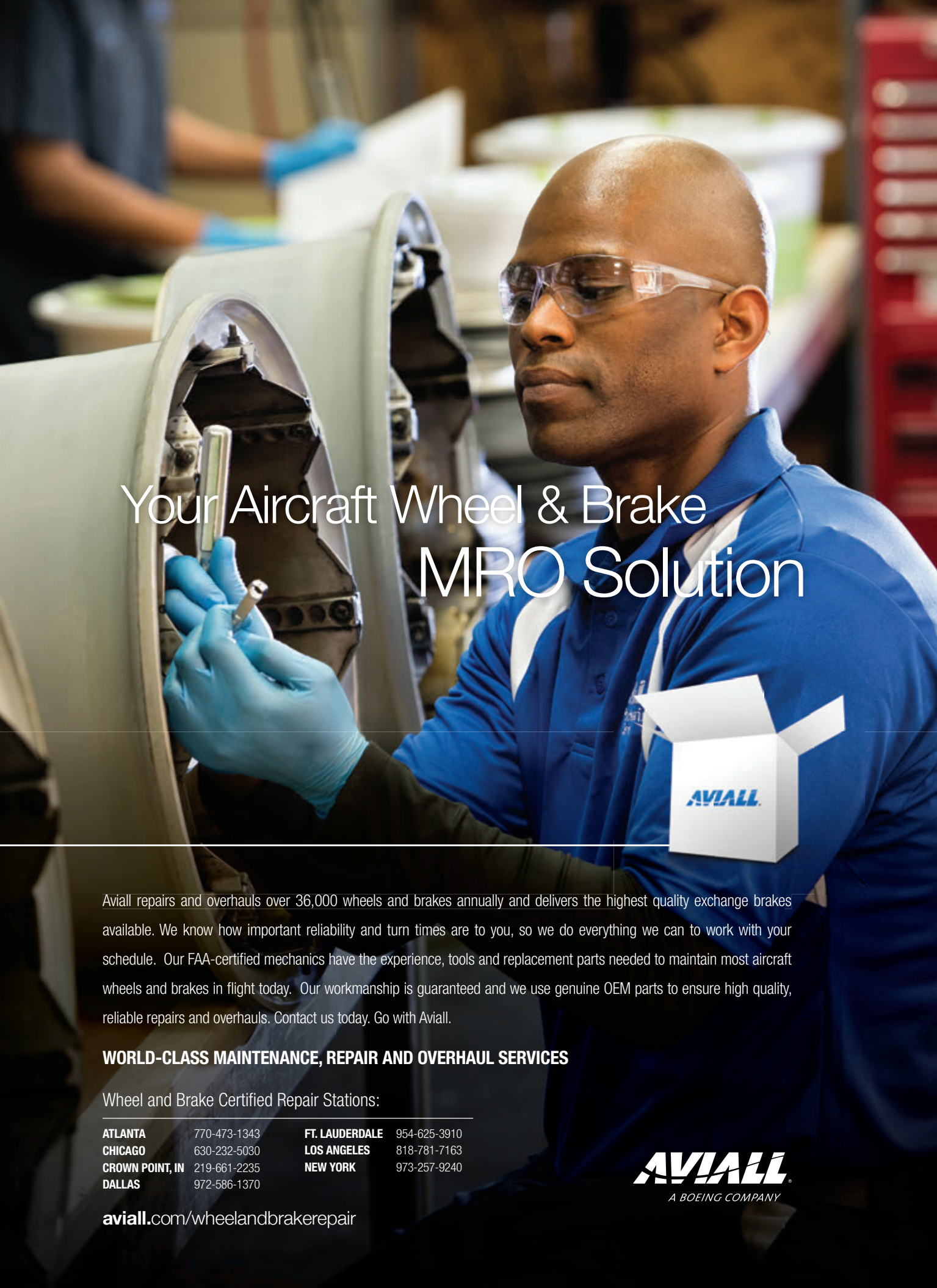

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WHAT IS YOUR **SINGLE BIGGEST CONCERN?**

I recently reviewed the results of the 2016 *Aircraft Maintenance Technology* Readership Survey, where readers responded to 30 plus questions ranging from the respondent's specific role, the segment of the industry they work in, to what keeps them up at night.

What caught my attention this year was the change in answers to this one question, "Which single issue is your biggest concern". In years past you could count on a certain blend of answers ranging from parts and material availability, to regulatory authority issues, to lack of technical information — standard stuff you could say. The top two answers this year climbed up from within the list of options. In order of ranking they were; Training on the complexity of aircraft today, and Recruitment and retention of technicians.

No real surprise but what I believe is significant is how these two issues have rapidly risen to the top of the list. The other important point to mention is the respondents came from all segments of the industry, General Aviation, Business Aviation, Airlines, Repair Stations, Rotorcraft, and from people in all types of roles: technicians, managers, directors, and CEOs.

Based on this, it appears many if not most of you have the same or similar "biggest concern". Aircraft have become much more complex requiring additional and relevant training to safely maintain them, and almost hand-in-hand comes finding, hiring, and retaining the right talent.

The topics of training and workforce surface in nearly every conversation I have with those of you who work in the industry. Last month I attended the Aviation Technician Education Council's annual Legislative Fly-In and board meeting in Washington, D.C. ATEC member educational institutions and industry partners made their way around Capitol Hill meeting with legislators to discuss FAA rule changes affecting aviation maintenance schools to the concern about the increasing talent shortage in aviation.

You are all aware the current curriculum used to teach new aircraft technicians is very outdated and industry has been asking educational institutions to teach relevant technical subjects. Yet, the Part 147 aviation maintenance technician schools are required to teach many outdated subjects by today's complex aircraft standards. Over the past few years since I became an industry member on the ATEC board, I've seen and been part of a shift. With new and active members, the ATEC organization has pushed FAA on the Part 147 rulemaking, engaged industry partners, and constantly interacts with government agencies to push the aircraft maintenance workforce development concerns forward.

But one organization cannot do this alone. Industry needs to become involved within your company, your community, and the organizations that work hard to support your industry.

Ron

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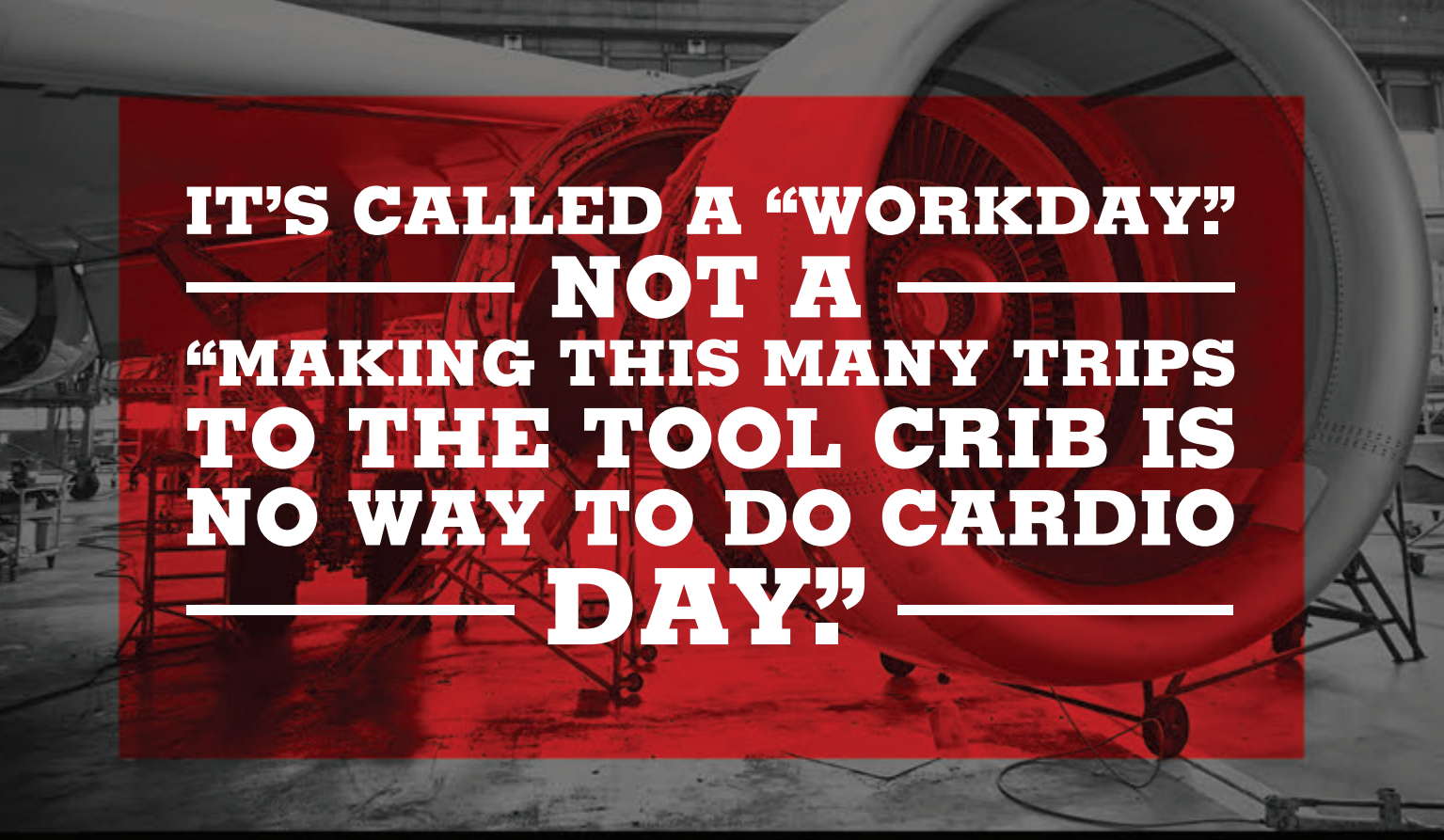

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WITH HELICOPTER fuselages so low to the ground, these aircraft require special attention to detector mounting and field of view (FOV) to ensure coverage under, over, and between rotorcraft.
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HOW TO KEEP PACE WITH FIRE PROTECTION FOR AIRCRAFT MAINTENANCE HANGARS

Protecting expensive aircraft assets, maintenance hangar structures, and the human life inside requires a fire protection system designed to meet the unique challenges presented by the aircraft themselves and the MRO operations that take place in the hangar

By Mike Hosch and John Jarvis

Commercial and military aircraft MRO operations play a huge role in keeping modern aircraft in service by taking on new tasks and responsibilities with every industry development. The demands on hangar fire safety systems have grown right along with today's MRO challenges.

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longer. Today's commercial maintenance, repair and overhaul (MRO) facilities are faced with all of these challenges — and also with the opportunities they bring. Military maintenance hangars deal with many of the same issues plus the ever-increasing demands of advanced aircraft technologies, electronic warfare equipment, and readiness requirements. And that means fire detection systems are also evolving with the aircraft they protect.

Amidst all this change, there is one challenge for aircraft MRO facilities that remains a constant, and that is the need for fast and reliable hangar fire detection and suppression. Protecting expensive aircraft assets, maintenance hangar structures, and the human life inside requires a fire protection system designed to meet the unique challenges presented by the aircraft themselves and the MRO operations that take place in the hangar.

There are a number of standards, certifications, and regulatory agencies to satisfy when it comes to aircraft hangar fire detection. Fire protection codes by the National Fire Protection Association (NFPA) such as NFPA 409, military standards, insurance companies, and authorities having jurisdiction (AHJs) may require or strongly recommend a high-performance fire detection and suppression system to protect aircraft assets, the hangar structure, and human life. Military hangars are subject also to the U.S. Department of Defense's (DOD's) Unified Facilities Criteria (UFC). The current UFC 4-211-01N includes all of the NFPA 409 requirements plus additional stringent measures in areas such as the fire barriers, fire resistance ratings, and suppression.

Due to the specialized and sometimes hazardous operations that take place in maintenance hangars, there is a specific NFPA standard for aircraft MRO facilities: NFPA 410 Standard on Aircraft Maintenance. This 2015 document references several contributing guidelines — each related to a specific maintenance activity — including NFPA parts 30, 33, 70, 326, 407, and 409.

FIRE HAZARDS INHERENT IN MRO OPERATIONS

As stated above, the overhaul, repair, and service operations performed on aircraft involve potentially hazardous materials, equipment and processes — and many of these have fire safety implications. Here are some of the maintenance services specifically addressed in NFPA 410 and why:

- Electrical equipment such as power units, aircraft electrical systems, and chargers are possible ignition sources that need to be kept separated from flammable fuel sources like fueling points, tank vents, and fuel line drains.
- Aircraft breathing systems present an intrinsic risk of fire or explosion due to the presence of oxygen, so storage, maintenance, and recharging are only permitted outside the hangar.
- Aircraft fuel system maintenance, which requires fuel storage and transfer, is another fire risk. All operations involving gasoline and fuels with a flash

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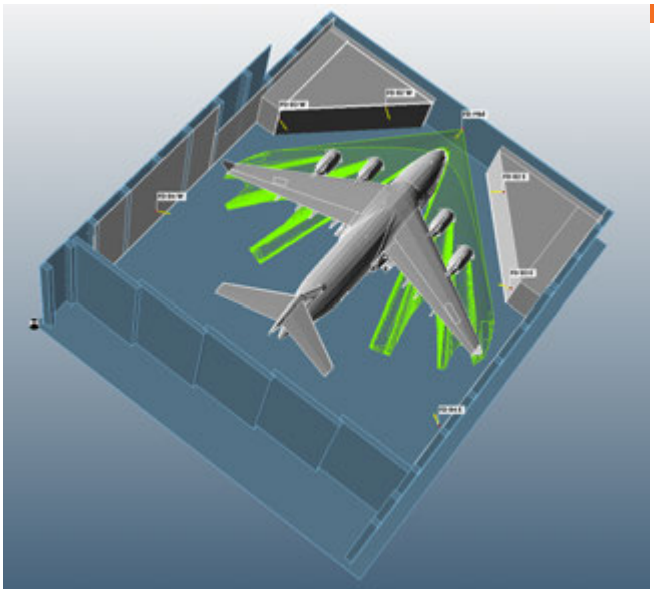
point under 37.8 C (110 F) must occur outside. The fuels allowed in hangars present a fire risk if located where open flame or spark-producing equipment is used.

• Aircraft welding operations involve the use of an open flame, so these activities must be completely isolated from hazardous activities such as fuel transfer or painting.

• Exterior painting of large aircraft is a significant challenge for hangar fire protection. Unlike automobiles or smaller aircraft whose components can be painted in controlled environments prior to assembly, aircraft exterior painting is a final operation that involves crew members using sprayers. The implications for fire protection are significant, from fuel-related hazards to the circulation of highly flammable paint plumes under and around wings and fuselage.



CERTIFIED FIRE Protection Engineers and other hangar experts use 3-D flame mapping software to assist in determining detector placement so that the area of coverage is maximized and meets project specifications; the example shows the field of view (FOV) of the detector positioned at the front of the plane. DET-TRONICS

DESIGNING A FIRE DETECTION SYSTEM FOR MRO HANGARS

Because the specialized operations undertaken in maintenance hangars can be hazardous, the fire protection and suppression systems that protect MRO hangars must be equipped to address these unique requirements. Considerations essential to the planning, design, and implementation of the fire protection system include an analysis of the type of detectors used, how and where they are distributed, response times, and how effective they are at rejecting false alarms. Below are some design, performance, and commissioning factors to consider when thinking about fire protection for today's MRO facilities.

1. Ability to detect flame in addition to heat and smoke

Historically, heat and smoke detectors have played the pivotal role in fire detection systems in maintenance hangars. However, in open or drafty areas such as hangars, smoke and heat from a fire can dissipate and significantly delay detection or evade it altogether.

Traditional smoke and heat (thermal) detection systems are intended to provide protection for the hangar structure. Now optical flame detectors are being used to provide an earlier notification of the presence of fire, which in turn provides better protection of the ever-more-costly assets inside. High-performance optical flame detectors with a wide field of view (FOV) and long detection range can sense a 2-foot by 2-foot fire from up to 235 feet (71.638 meters) away. This superior performance enables detection and notification much more quickly than traditional protection schemes.

2. Fast detection and decision making

Automatic activation once heat or flame thresholds have been reached is a very effective way to speed detection and decision making. An aircraft fuselage skin can be damaged in as little as 45 seconds after initial contact with fire.

The time that it takes an activated suppression system to extinguish a fire depends on a number of factors and is quite variable, ranging from a few seconds to minutes. The UFC guidelines established for U.S. military hangars specify that the time from actuation of an aqueous film forming foam (AFFF) system to discharge of foam at the most remote nozzle must not exceed 30 seconds. If it is reasonable to allow 30 seconds between activation and the time that AFFF is hitting the flames, then the detection and activation system must receive and analyze data from multiple detectors, make error-free decisions, and dispatch activation and alarm messages, in no more than 15 seconds. This response time is well within the response time of modern optical flame detectors.

3. Optimally located detectors — aided by 3-D mapping

Expansive areas like hangars require comprehensive fire coverage, so an optical flame detector's range and FOV are critical. Generally speaking, the greater the detector range and FOV, the fewer devices needed to achieve full coverage.

Optical flame detectors must be positioned so they have a view beneath the aircraft's wings and fuselage. Therefore, detector mounting heights are often dictated by the smallest aircraft stored in the hangar. It is equally important, however, to consider possible obstructions such as maintenance equipment. This is where 3-D mapping comes into play. 3-D flame mapping is used to determine nominal placement and aiming so that detector coverage is maximized and blind spots are eliminated. In addition to providing a highly illustrative three-dimensional diagram of the installation, a detailed soft-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LEFT IMAGE shows the soot and smoke generated by traditional pan fire testing versus an improved proof-testing methodology using a patent-pending Jet Fuel Flame Simulator.

PHOTOS COURTESY OF DET-TRONICS INC.

ware-driven approach generates quantitative statistical analyses that help raise the safety level of the site. Three-dimensional mapping can also provide reports and data essential for ongoing maintenance and for satisfying regulatory agencies, insurance claims, and audits.

4. Ability to reject false alarms

MROs' ever present goal is to turn aircraft around fast, and little can stop work faster and for a longer period of time than a false fire alarm that triggers a deluge fire suppression system. In order to reduce the probability of false alarms and unintended activations, it is imperative to use detectors that are highly resistant to false alarm sources, and also proven to be unaffected by electromagnetic interference/radio frequency interference (EMI/RFI) energy.

Maintenance hangars also include sources of friendly fire that must be filtered out. For example, in cold climates, gas-fired heaters are often used to heat hangars. When these heaters start up, a flame may momentarily exist within the heater which could possibly be within the FOV of a detector. These 'real fires' can become a source of alarm. As such, flame detection systems must be equipped with processing algorithms to ignore short-duration flames, while still providing optimal detection capability to liquid pool fire type hazards.

5. Commissioning – an alternative to jet fuel fire pan testing

One requirement of system commissioning is proving that the installed detectors can quickly and accurately sense the presence of jet fuel fires. Traditional pan fire testing requires literally lighting jet fuel in pans set on the hangar floor. The jet fuel tends to boil and splatter, while the fires generate smoke and soot on hangar surfaces. The result is a mess requiring considerable cleanup work. The unused, partially burned fuel also presents a hazardous waste disposal issue. A new testing alternative has been used in commissioning recently that involves a patent-pending jet fuel fire simulator. This device uses LP (propane) gas to produce a calibrated fire that has the unique spectral and flicker characteristics of a jet fuel fire, thereby enabling detector performance testing without damage to pristine hangars.

SPECIAL CONSIDERATIONS IN MILITARY HANGARS

The MRO facilities that support U.S. Air Force, Army, Navy and National Guard aircraft need to accommodate some additional factors not usually seen in commercial hangars, such as:

Detector placement issues for rotorcraft. Helicopters present special challenges for fire detection equipment because they are both low to the ground and tall. The primary location of a fire would be from a leak from a tank in the fuselage of the aircraft. When the aircraft sitting, in many instances, only 1 or 2 feet off the ground, detectors need to be positioned to see underneath the helicopter. A competing challenge is locating detectors above obstructions found in the hangar itself. Equipment and materials are often stacked along the walls, which means detectors also need to be positioned above obstacles to see both the near side and far sides of the helicopter, between helicopters and all the way across the hangars. The use of 3-D mapping to determine detector placement can be very valuable in hangars with challenging layouts.

Immunity to military avionics emissions. Potential EMI/RFI interference with detectors is a consideration even in commercial hangars, but it is a more significant issue in military hangars due to electronic warfare equipment designed to operate in multiple parts of the spectrum (to confuse oncoming missiles, for example). Military pilots often "light up" electronic warfare equipment as the aircraft is taking off, which can inject electromagnetic interference into the interstitial space of the hangar — interference that can result in false alarms.

LEARNING FROM MILITARY STANDARDS

On the topic of heat detection versus optical flame detection discussed earlier, U.S. military branches use optical flame detectors as part of fire protection systems for military hangar construction:

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ALL BRANCHES of the U.S. military employ optical flame detection as part of their fire protection systems to protect their high-value assets.

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RIGHT: The U.S. Army specifies that Infrared detectors to be used in new hangar construction should be provided with blinds (sight limiters) to ensure detector FOVs do not extend beyond the spaces to be protected.

ENGINEERING AND CONSTRUCTION BULLETIN 2015-017

- UFC 4-211N, which is adhered to by the Navy and Marines, specifies the use of a multispectrum infrared (IR) flame detector that is listed/approved for the expected fuel hazards in the hangar bay and is immune to radar and radio frequency emissions.
- The Engineering and Construction Bulletin (ECB) developed by the Army (ECB 2015-017) specifies optical flame detector attributes that include EMI immunity, the presence of blinds (site limiters), and arc welding rejection, strobe light rejection, and sunlight rejection.
- Several Air Force bases also employ optical flame detectors.

False alarm rejection has played a critical part in these branches of the military implementing optical flame detection as part of their fire protection systems.

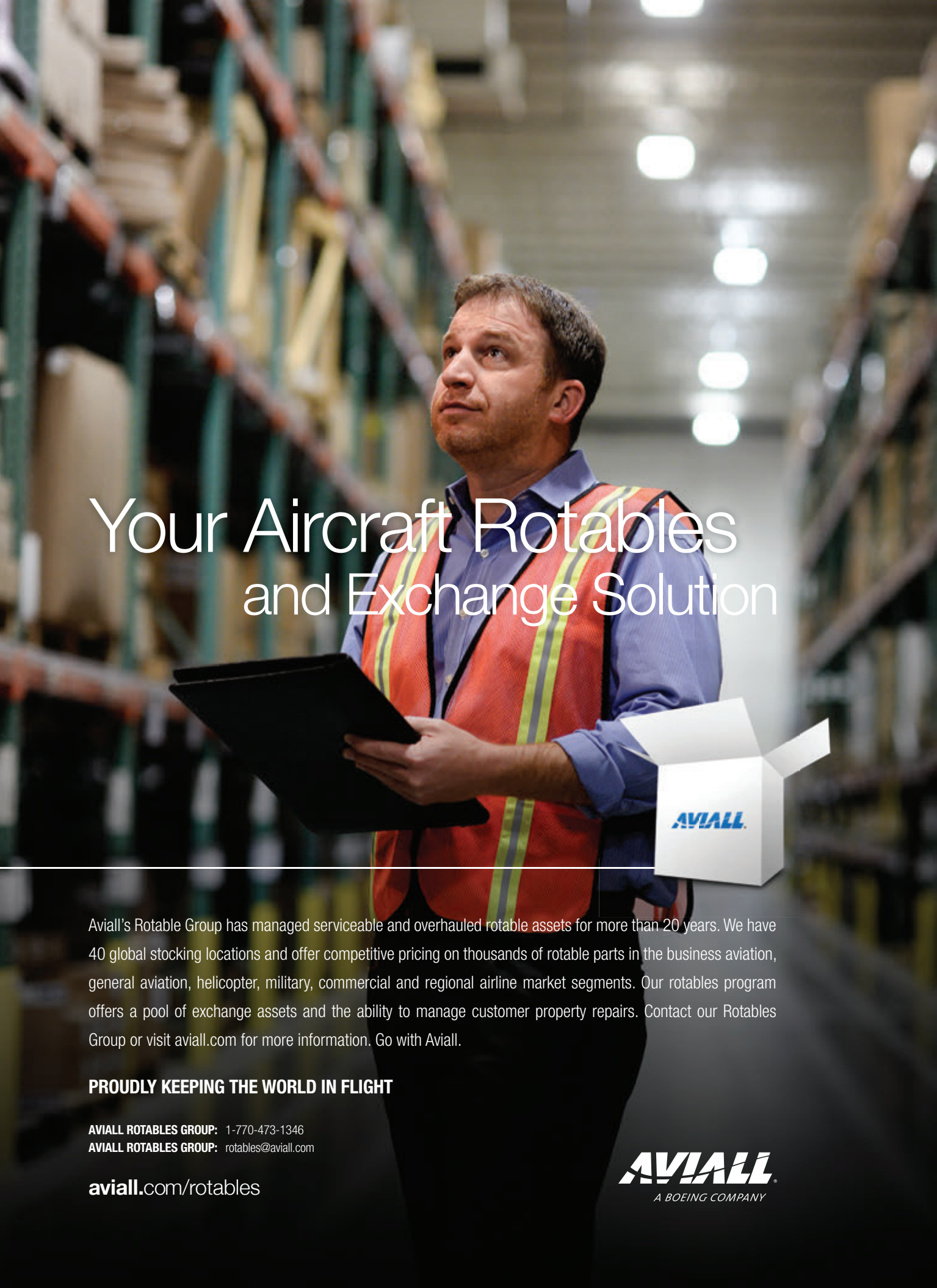
CONCLUSION

Maintenance hangars perform highly specialized, mission-critical functions, so fire detection and suppression technologies need to keep pace with MROs' constantly evolving protection needs. This includes enhancing heat and smoke detection systems with optical flame detection capabilities, using 3-D mapping and analysis to validate optical flame detector placement and positioning, and employing the most up-to-date commissioning tools such as jet fuel fire simulation for proving detector performance.

Providing fire protection for MRO facilities is certainly a task for the industry's experts, but knowing what is available for aircraft hangar fire protection is a critical aspect of every MRO facility manager's job. ***AMT***

MICHAEL J. HOSCH is employed by Det-Tronics in Minneapolis, MN, as the Flame Detection Product Line Manager. He has worked with optical flame detection for Det-Tronics for over 25 years and has recently been focused on providing support to the company's customers in applying optical flame detection within commercial and military aircraft hangars.

JOHN JARVIS joined Det-Tronics in 1998 and has held numerous roles in engineering, and sales and marketing. He has extensive experience in the design, development, and applications of many of Det-Tronics products. John holds a Ph.D. in chemistry from Kansas State University as well as MS and BS degrees from Pittsburg State University.



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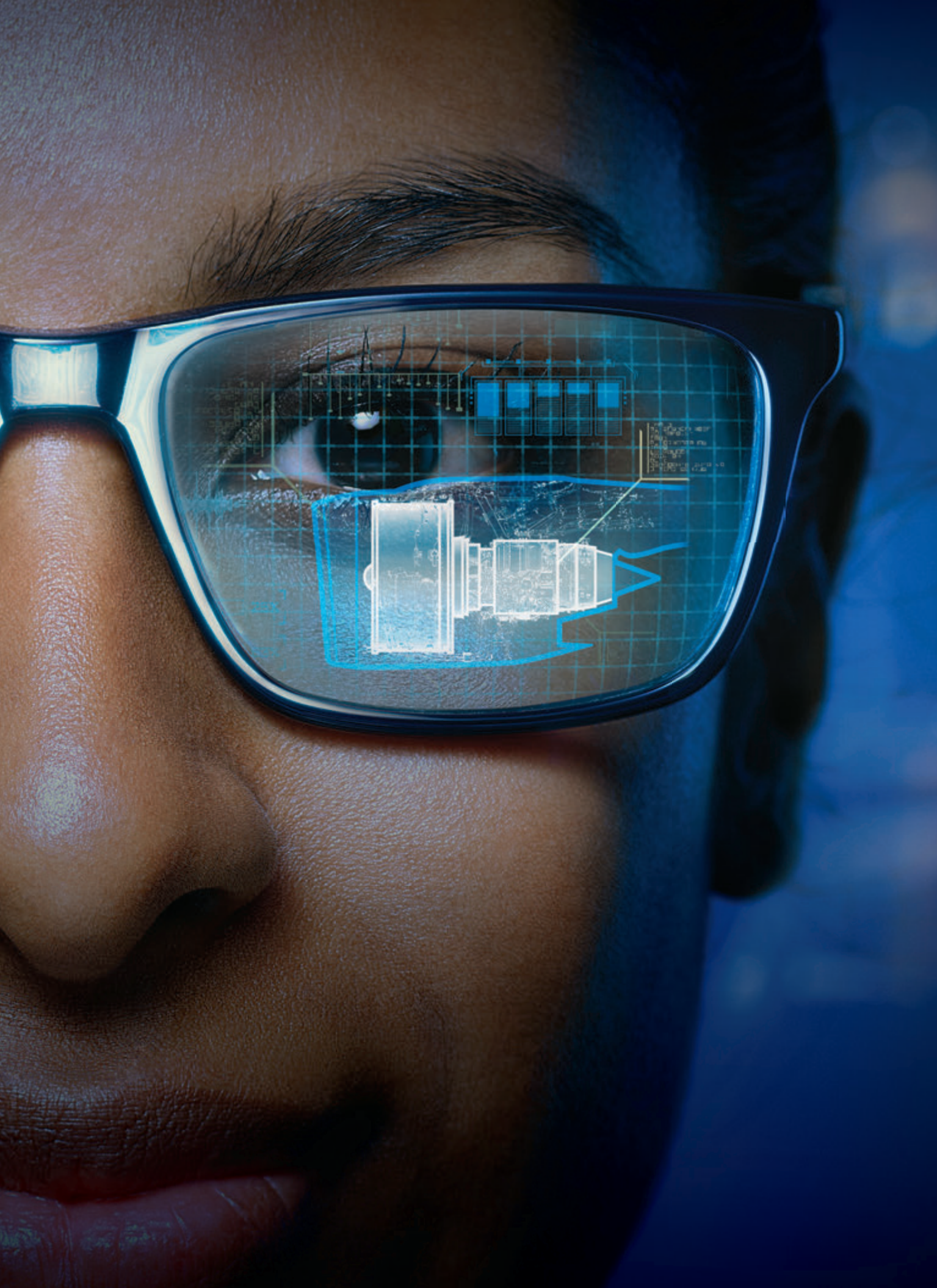

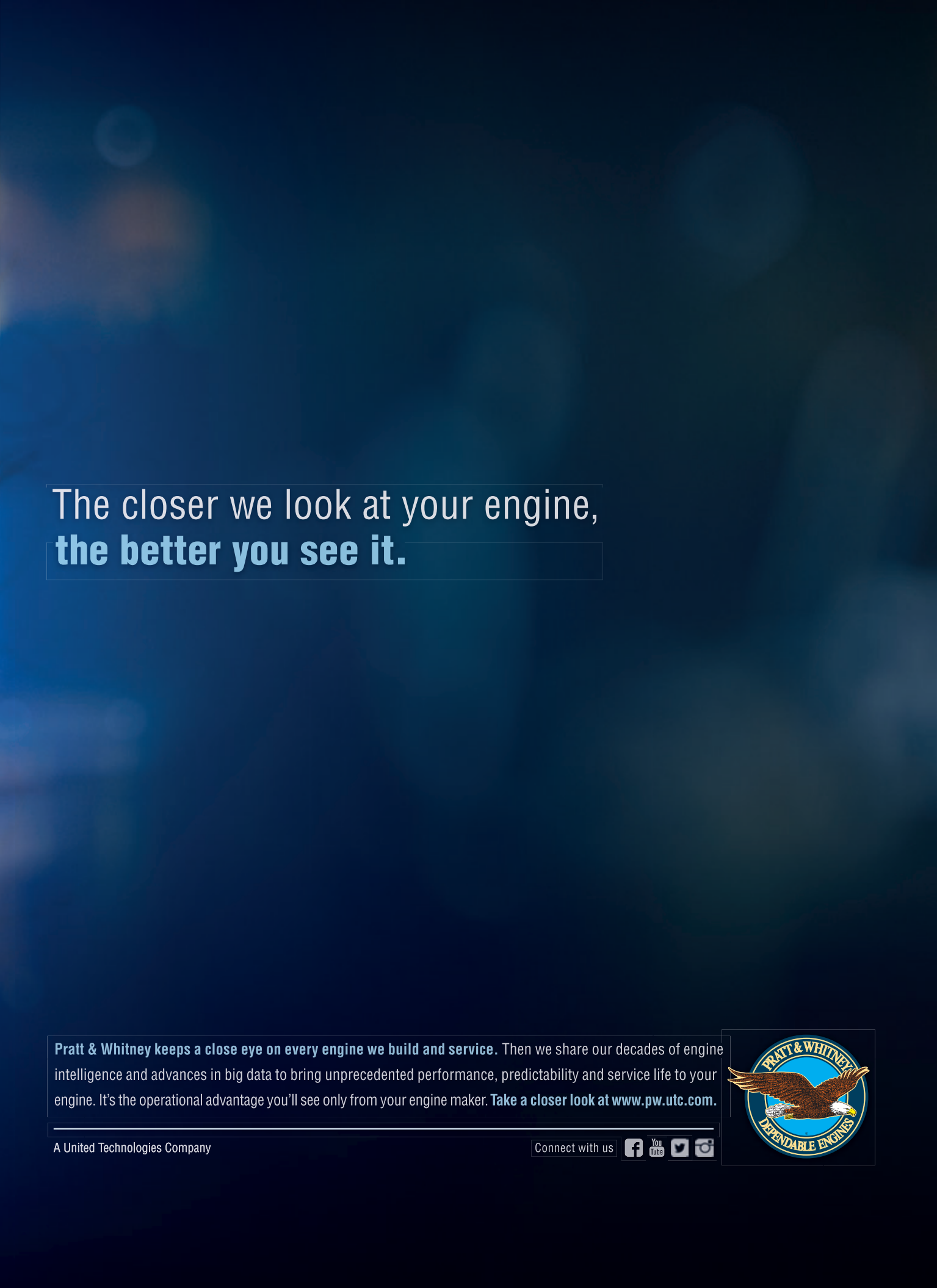
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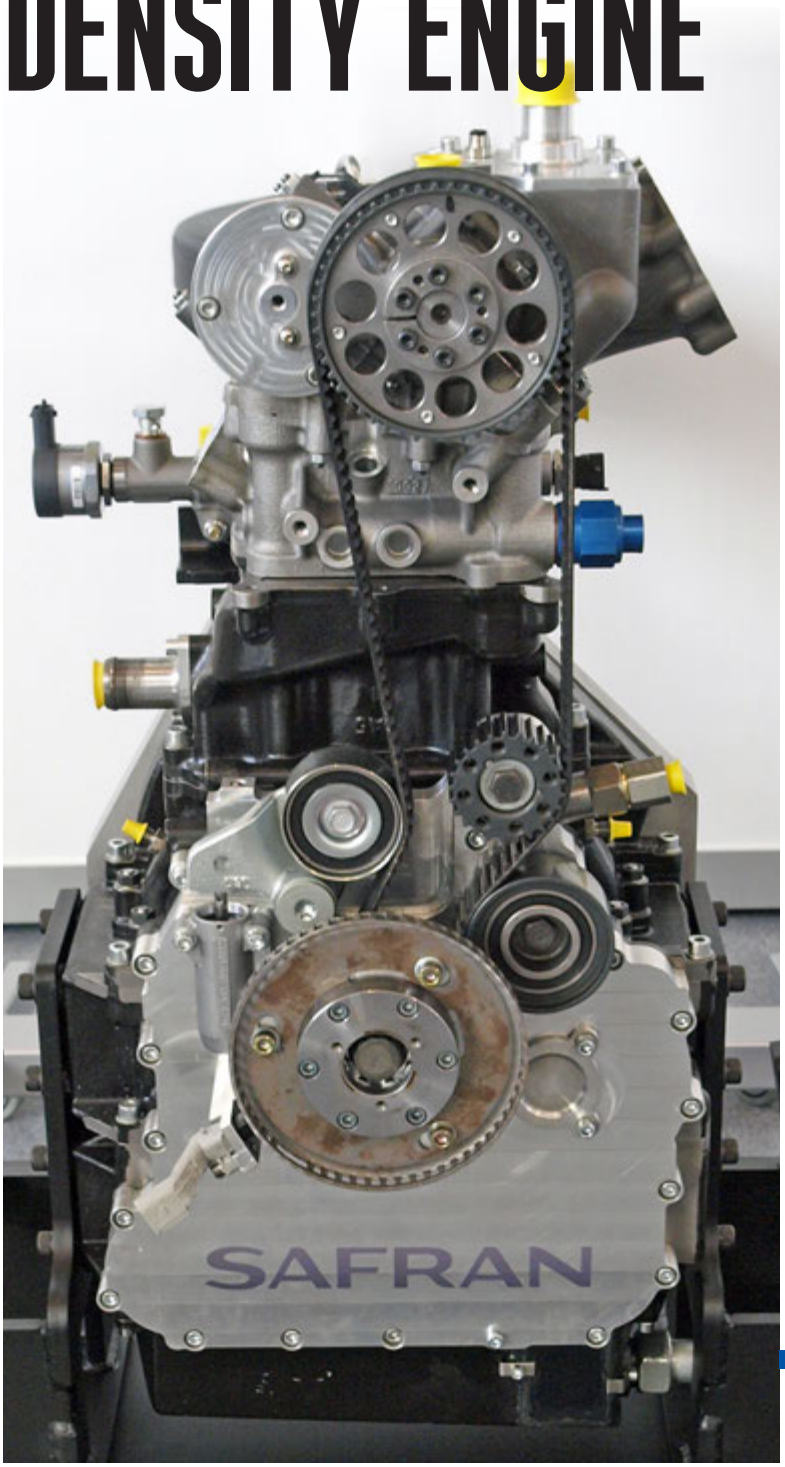


THE DEMONSTRATOR HPD, a four-stroke, diesel cycle, one-cylinder engine, with only 38-cubic-inch (0.62 liter) displacement develops 135 hp (100 kw).

It allows aircraft to increase payload, range, and endurance, while operating on jet or bio fuels, reducing CO2 emissions and noise

By Marino Boric

DURING THE LAST AERO 2016 AVIATION EXPO in Germany, the SMA debuted a diesel-cycle, engine demonstrator with unprecedented, hard to believe, high power density, which could be able to compete with turboprop powerplants in the 400- to 800-hp power range. Is this — finally – a breakthrough in the diesel, piston engine field? A new hope for the GA? *AMT* European Correspondent Marino Boric inquired and collected the following information.

According to the French SMA (100 percent subsidiary of Safran Aircraft Engines) the research demonstrator HPD, a four-stroke, diesel cycle, one-cylinder engine, with only 38-cubic-inch (0.62 liter) displacement develops 135 hp (100 kw). This data are according to SMA not theoretical assumptions but practical (dyno) measurements. This is the equivalent of 215 hp (160 kw) per liter displacement with a specific fuel consumption of 0.35 lb./hp/hr. (210 g/kwh) and thus according to SMA it is a world champion in this field. Making a projection, this will mean that an 800-hp, 3.7-liter displacement engine could weigh only 533 pounds (240 kg) and feature an almost incredible 1.5 hp/lb. (2.5 kw/kg) power density.

A WORLD CLASS PISTON ENGINE IN POWER DENSITY

According to SMA this high power density engine (HPDE) equals the small turbines by weight, yet

retains the low fuel consumption of compression ignition piston engines slashing the turbine consumption at least by half.

This design apparently surpasses all other available powerplant options allowing aircraft to significantly increase payload, range, and endurance, while operating on jet or bio fuels, reducing CO2 emissions and noise. As a comparison, this design exceeds best-known diesel engines like the Le Mans 24h car endurance racing LMP1 engines by 15 percent in power density and by 30 percent in specific power, yet matches a typical aircraft engine service life.

HOW DOES IT WORK?

SMA is not (yet) willing to unveil the secrets of the HPDE engine as many technologies are right now being patented but the key seems to be in the much different, on purpose, designed engine. SMA says that the key is to design the engine from the ground up only for aeronautical application, and for only one optimized design point. Automotive applications have to be optimized for several design points that lead to (too) many compromises.

The HPDE concept is optimized for engines in the power range from 400 to 800 horsepower (hp). According to SMA, below 400 hp, the concept is limited by the packaging, and above 800 hp the weight penalty becomes too high to compete with gas turbines.

SMA's benefited from SAFRAN's know-how and used a mix of patented parts and off-the-shelf components from the automotive industry which enabled SMA to break new frontiers.

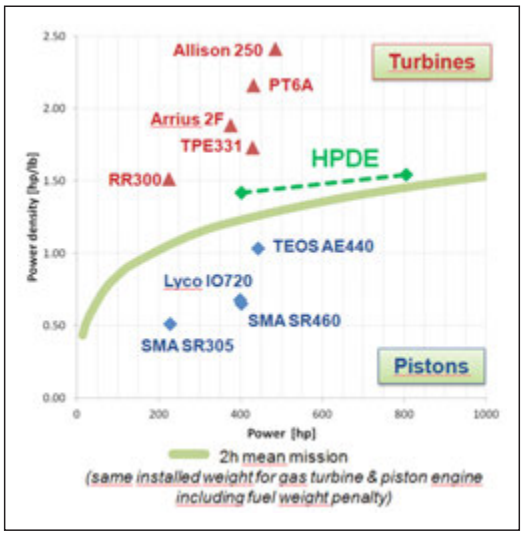
GENESIS OF THE ENGINE

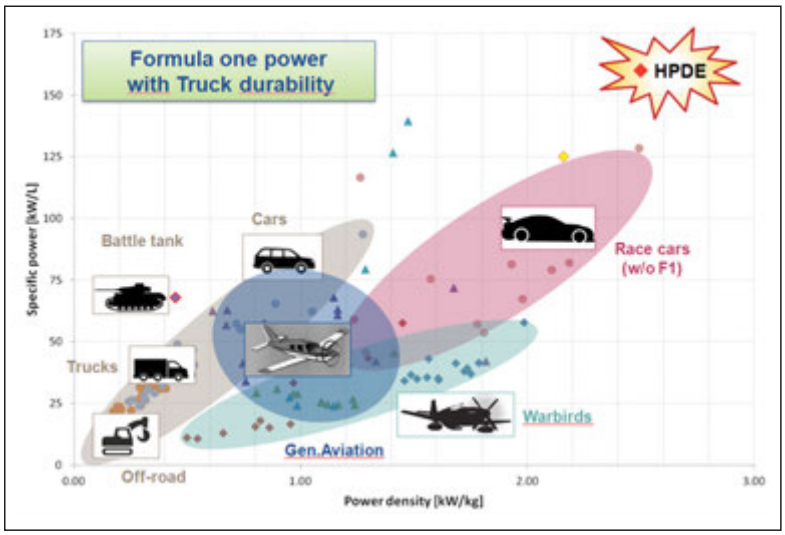
The goal was to design a high power density, jet-fuel burning engine in the power density range of turbines, but with the low fuel burn of compression ignition engines (CIE).

Turbines are well known for their high power-to-weight ratios, but in the low power range their fuel burn is between two and three times higher than the compression ignition engines fuel burn.

Turbine wheels are optimized for high power settings that lead to a loss of efficiency in partial load operation in cruise flight. Compression ignition engines maintain a relatively constant specific fuel consumption throughout their power range.

SMA investigated which design could





offer an opportunity to implement a piston engine instead of a turbine with similar packaging, the same power output but with half the fuel consumption. One of the main challenges was to guarantee a durability equivalent to a gas turbine with the same reliability level. The SMA goal was to design a piston engine burning Jet-A fuel, with the power density of a Formula 1 race-car engine, but with a truck engine durability. To achieve this challenging goal, SMA figured out that this is doable only by a brand new concept and not by a conversion of an automotive powerplant.

THE SMA CONCEPT

After a deep benchmarking, the SMA task-force identified different pathways to reach the goal; many possibilities were considered, from immature but very promising technology like liquid piston engines and combinations of new and classic automotive solutions. Engine concepts used in racing applications were a good compromise to reach the power density in a fair timescale. They are able to deliver the predicted power, but they lacked durability and cost efficiency. SMA found the best compromise for desired range of power in a "classical" four-stroke engine in which piston geometry, injector performance, turbo efficiency, and lightweight technologies were selected.

In 2014, the team designed the combustion chamber and established the parameters to confirm the potential. A single-cylinder device was created to explore the full capability of the concept. The optimal configuration solution remained open — an in-line or boxer arrangement is possible — and depends on the final customer requirements.

2015TH MILESTONE

The first step was achieved in late 2015 with the combustion chamber design validation, including piston and cylinder shapes, air inlet/outlet, injection, etc. developed in partnership with the Clean Sky European program. The project presentation occurred in April 2016.

POSSIBLE APPLICATIONS

For the final multi-cylinder (to be developed) engine a full range of applications has been considered: from a propulsive engine mechanically driving a propeller to a range extender, including hybrid architectures generating electrical power for use in general aviation and unmanned aerial vehicles.

The most beneficial use of the HPDE engine is for long distance and endurance missions. UAVs are the most promising applications as this new engine can double the mission range or endurance.

The HPDE concept can be developed for in-line or horizontally opposed configurations depending on the room available on the target aircraft. The best compromise can be achieved with a six-cylinder engine weighing (installed) about 530 pounds (240 kg). The SMA multi-cylinder engine could be used as a light-weight and efficient jet-A power generator, or as a range extender with 1.5 hp/lb. (2.5 kw/kg). **AMT**

MARINO BORIC graduated with a university degree as an aeronautic engineer, and acquired degrees in business development/trade and commerce and in journalism. He is a civil and military pilot and has built experimental aircraft. As a journalist, he specializes in aviation and propulsion and travels worldwide, flight-testing UL, LSA, Experimental, and certified aircraft. He is writing for U.S., European, and Chinese media companies.

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THE BUSINESS OF WHEEL AND BRAKE MRO

Every time an aircraft takes off or lands it is getting one step closer to needing work from a wheel and brake MRO.

By Phill Randell

One of the often overlooked, and certainly the least glamorous area of aircraft are the wheels and brakes. Essential to the start and finish of each flight and of course all ground movements, these expensive assets undergo tremendous force, environmental and temperature variances on each and every flight.

The regional and commercial aircraft wheel and brake market is dominated by four OEMs, namely: Honeywell, UTC Aerospace, Meggitt, and Messier-Bugatti-Dowty. All products follow a similar construction, although boltless wheels are becoming more popular now, as are carbon brakes.

UPPER: Inside the World Aero facility near London, England.

LOWER: Boeing 737NG wheel undergoing a high frequency eddy current test during overhaul at World Aero.

ALL IMAGES COURTESY OF WORLD AERO

UNDERSTANDING THE MAINTENANCE CYCLE

Wheels and brakes are normally removed from the aircraft "on condition", either when the tyre tread or brake friction material is worn to limit. This limit is ascertained by line maintenance staff, and the entire wheel/tyre assembly or brake is then routed to a workshop for refurbishment. A tyre can be changed on an aircraft wheel several times before a full overhaul of the wheel is required; similarly the friction material in a brake is replaced several times before a full overhaul is required.

With the extremes in environmental conditions experienced by wheels and brakes, **corrosion is a major problem** and it is only on overhaul that the opportunity exists to monitor, remove, and protect against corrosion.

Tyre change (minor service) requires basic disassembly, cleaning and inspection of the wheel before a fresh tyre is fitted, the wheel reassembled and bearings greased. A wheel overhaul (major service) requires complete disassembly, paint removal, comprehensive NDT, and visual/dimensional inspection, before new paint is applied and the wheel built for return to service. The cost difference between tyre change and overhaul is considerable, and the maintenance schedule is written to permit a safe number of tyre changes before overhaul. Brakes follow a similar process, based on the OEM's recommendations.

This cycle of minor/major inspections is often poorly understood by operators with many just carrying out multiple tyre changes without overhaul, which presents an airworthiness risk but more commonly results in a higher number of irreparable units due to corrosion that has gone unnoticed. With the extremes in environmental conditions experienced by wheels and brakes, corrosion is a major problem and it is only on overhaul that the opportunity exists to moni-

MESSIER-BUGATTI-DOWTY A320 main wheel.

tor, remove, and protect against corrosion. A Boeing 737-300 wheel, for example, might require an overhaul every five tyre changes, based on an average tread life of 275 cycles per tyre tread. A more modern aircraft, such as Embraer E190 series, for example, requires an overhaul every other tyre change due to the fact that tyre life regularly exceeds 850 landings per tyre tread. These limits, essentially based on total cycles or calendar limits, are in place to ensure the wheel is maintained on an acceptably regular basis.

OPERATION AFFECTS SHOP INPUTS

There is a direct correlation between traffic numbers and shop inputs for wheels and brakes. Numbers however also fluctuate hugely depending on the seasons,

WORLD AERO tyre store room.

not just down to operators' schedules but the conditions in which the aircraft are operating. A northern hemisphere summer for example brings an increase in holiday traffic boosting flights and thus wheel and brake removals. But also hot conditions with hot runways, heavier aircraft, or tighter turnarounds — all of which reduce the life of the tyres and to a lesser extent, the brakes. Different routes can have a heavy impact on removals; runway conditions and manoeuvring area dimensions can make one route's tyre consumption vastly different from another. Contrary to opinion, it isn't the spin-up of the tyre on landing releasing the puff of smoke that wears the tyre, it is more the sharp turns made by the aircraft during ground manoeuvres that cause the most wear. Aircraft that operate

tight schedules into inner city airports with very compact ramp areas see far less tread life than those operating into larger airports.

As aircraft numbers increase, there is an upward shift in the number of wheels and brakes flying, and thus requiring servicing. However, as tyre and brake technology improves, the "on-wing" life of wheel and brake units is increasing massively, so the actual shop inputs worldwide has plateaued in recent times. These technological advances are brought about by the introduction of radial tyres and carbon heat-packs, which are standard equipment on all new aircraft types. However, there is still great longevity in legacy aircraft, which rely on proven, unchanging technology for wheel and brake units.

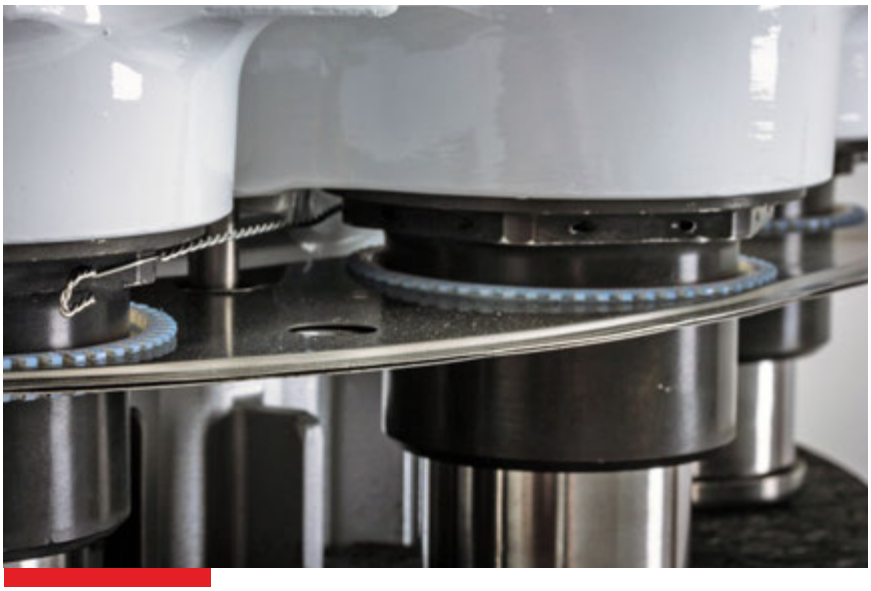
The wheel and brake MRO market is dominated by OEMs who have their own repair shops in central locations around the world. The huge cost of development, testing, and certification of wheels and brakes, coupled with the fact that many OEMs often provide the actual wheels and brakes free-of-charge to an aircraft purchaser, mean that in-service support is the only way to recoup the cost of bringing a wheel and brake product to market.

The cost of development is recovered through the supply of spares or through the supply of MRO services, and thankfully for the OEMs, as wheels (and especially brakes) have many consumable parts, the opportunity for spares supply is great and constant. The OEMs are very keen to support the major operators, particularly those with large fleets fitted with one OEM specified wheel and brake type.

THE INDEPENDENT MRO

The wheel and brake MRO market, although dominated by the OEMs and airlines that have invested in their own workshops at the larger scale of operations, is a thriving sector of the MRO business and is well represented worldwide by many independent workshops.

World Aero is one such independent wheel and brake MRO. Based in the UK, we were formed in 1999, obtaining EASA Part-145 approval in 2008, and subsequently TCCA and FAA approvals. Focussed largely on Boeing 737 and A320 product, we invest in equipment, facilities, and manpower to deliver large volumes of consistently high quality product. Our location close to London means we



A321 BRAKE unit.

are well placed to support a large number of aircraft.

In the highly competitive wheel and brake industry, we have found that in order to stay ahead we must make good use of lean processes — delivering more product on less resource, whilst still maintaining high quality levels. We have learned that investment in tooling and equipment is key to success, to enable technicians to perform their tasks in a straightforward and productive manner. We train our employees in-house so that efficiencies in production are instilled from the outset — a measure which we hope will lead to long-term steady growth for the company.

Indeed, from working on 500 units in 2009, we repaired more than 3,400 units in 2015, with some 92 percent of these being full overhauls. We feel that such growth is only possible with a steady, long-term business model. Wheel and brake maintenance is straightforward, and done properly, should be the last item on the aircraft to cause an operator technical or financial worries.

Going forward, it is accepted that the OEMs will always seek to support the larger, flagship carriers that run only their product. However, there is a growing market of smaller airlines, and those that operate a mixed fleet of wheels and brakes, where the independent MRO can provide a good service more suited to that operation. And it's not just airlines, there is a market of course in business aviation, although the small size and straightforward maintenance of those wheels and brakes means a lot more can be done by aircraft MROs without needing the support of specialist workshops.

Every time an aircraft takes off or lands it is getting one step closer to needing work from a wheel and brake MRO. A variety of workshops offer solutions to meet every operator's needs and whilst none are trying to "re-invent the wheel," independence brings flexibility. ***AMT***

PHIL RANDELL is World Aero's managing director and accountable manager. An EASA Part-66 licensed aircraft engineer, he has experience with base and line maintenance for a variety of airlines and has also assisted with start-ups and maintenance contracts. Established in 1999, World Aero is an expert in aircraft wheels and brakes, providing aircraft wheel and brake component repair, overhaul, parts sales, parts exchange, and inventory management for international aviation customers; from commercial airline fleets to corporate jets. World Aero is a multi-release EASA, FAA, and additionally TCCA certified repair station.

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MTU: MEET THE ENGINE COMPANY WHERE REPAIR BEATS REPLACEMENT

By Marino Boric

MTU Maintenance is a major, global MRO company that offers services both in its maintenance shops and through on-site support missions — 24/7 and anywhere in the world. In this article we want to provide a general overview of the company's activities worldwide and just a rough impression *AMT* has gathered while visiting largest facility in Hannover, Germany.

Today, MTU Maintenance is a leading provider of commercial maintenance services for aircraft engines and industrial gas turbines. A business unit of MTU Aero Engines, Germany's leading engine manufacturer, MTU Maintenance operates a worldwide network of maintenance, repair, and overhaul facilities and representative offices. It is present in the most significant aviation markets and has locations in the Americas, Europe, and Asia. Included among them are centers of excellence for parts and component repair, as well as industrial gas turbines, for example. This network is complemented by on-site services that make the company truly global.

Since its foundation, the company has handled over 16,000 shop visits in over 35 years. Its engine portfolio includes best-sellers like V2500, CFM56, and the GE90. The total maintenance workforce is made up of 4,000 employees from 48 countries.

HANNOVER FACILITY IS UNIQUE IN EUROPE

MTU Maintenance Hannover is the centerpiece of the Maintenance Group and houses central group activities such as industrial engineering and repair development. The Hannover facility is the largest shop in the world and has the greatest program variety worldwide. The location serves 10 programs and has a workforce of 1,800. Furthermore, MTU Maintenance does everything under one roof — from engine tear-down, parts repair, to com-

MTU MAINTENANCE provides solutions for individual modules and repair services for spare parts and engine accessories.

ALL IMAGES COURTESY OF MARINO BORIC

plete overhauls and engine testing. This is a unique case in this industry.

The complete overhaul of engines in Hannover can take from two to three months and depends on the engine type and the workscope, as well as customer needs and preferences. Operators often prioritize ensuring downtime and maintenance costs are kept to a minimum what is usually a key priority. To this end, MTU Maintenance offers a host of service solutions. One of which is MTUPlus Engine Trend Monitoring, which monitors and evaluates a number of parameters with the aim of identifying technical problems before they can interfere with flight operations or cause costly repairs. Further, the data is analyzed by company experts who recommend corrective action wherever needed. This helps maximize on-wing times and avoid the need for unscheduled shop visits wherever possible. Right now, MTU Maintenance is looking beyond diagnostics and mere analysis of data delivered to prognostics and uses this knowledge to predict maintenance and better plan shop visits — across entire fleets.

Alongside its maintenance and overhaul service offerings for complete engines, MTU Maintenance provides solutions for individual modules and repair services for spare parts and engine accessories.

REPAIR BEATS REPLACEMENT

I could see in Hannover how MTU Maintenance repairs and overhauls engines — from incoming assessment all the way through to the test cell. Once an engine comes to MTU Maintenance for a visit, the use of alternative repair techniques and used serviceable material can help keep shop visit costs down. In fact, I saw for myself that MTU Maintenance focuses on repairing, rather than replacing parts of engines sent to the facility.

Besides OEM-licensed repairs, MTU offers specialized internally developed repairs and processes. All of these proprietary repairs are EASA/FAA approved and marketed under the trademark MTUPlus repairs. MTU Maintenance benefits from both technical expertise in engine maintenance and the specialist knowledge of MTU Aero Engines as an engine manufacturer — which is usually not a rule in this industry. The company focuses on developing and providing repair solutions for high-value parts, which can result in significant cost reductions for the customer. Furthermore, this type of repair focuses on the operational success of the engine and, therefore, can also mean a longer

THIS SET of hot-section blades shows various treatment steps after the removal from the engine (upper row, 1. left), cleaning, restoration till the reconditioned blade is ready for installation (lower row last to the right).

component service life, increased repair yield, and improved functionality. Repair development is facilitated by a highly qualified team of engineers, who draw from the experience MTU Maintenance has gathered over more than 35 years of providing MRO services. In addition, MTU Maintenance closely cooperates with local universities and research institutions, ensuring that it continuously employs the latest technologies.

Furthermore, MTU Maintenance undertakes repair development, not only for engines in which it has a development or production stake, but also for those that do not form part of its OEM portfolio. When it comes to repair development, MTU Maintenance offers cutting-edge technology.

MTUPLUS REPAIRS

The majority of these in-house and alternative repairs and processes have been grouped under the brand name MTUPlus repairs.

Following MTUPlus Processes are used for:

Turbines

- MTUPlus Balance Stripping
- MTUPlus Brazing
- MTUPlus Complete Protection System
- MTUPlus Flexible Laser Healing
- MTUPlus Internal Airfoil Cleaning
- MTUPlus Laser Powder Cladding - Tip Repair
- MTUPlus Multiply Plasma Coating
- MTUPlus Tip Protection
- MTUPlus Under Platform Coating

Fan/Compressor

- MTUPlus Engine On-Wing Cleaning
- MTUPlus ERCoateco Erosion-Resistant Coating

Combustor

- MTUPlus Dimple Spad Replacement

REPAIR DEVELOPMENTS

Furthermore, MTU Maintenance is especially proud of its repair methods; here are a few examples of recent developments and highlights in the field of coating techniques:

MTUPlus Under-Platform Coating, is able to give engine airfoils a new lease on life. By utilizing a patented high chromium coating, sufficient protection against severe corrosion from sulfur and alkaline deposits can be attained for high-pressure turbine blades. This results in reduced maintenance costs, less material wastage, and a positive environmental outcome.

The MTUPlus ERCoateco, erosion-resistant nano technology coating repair, was recently improved. When engines operate in harsh environments such as deserts or in salty air, the airfoils of a high pressure compressor (HPC) are more easily prone to erosion. This leads to an efficiency loss for the engine and to shorter on-wing times. ERCoateco provides superior particle and fluid erosion resistance as well as corrosion resistance. Cost savings will be achieved through a scrap rate reduction of up to 30 percent, a decreased specific fuel consumption of up to 0.5 percent, reduced CO2 emissions, and increased on-wing times.

MTUPlus CMAS Resistant Thermal Barrier Coating is similar to the MTUPlus ER Coateco. This repair technique helps operators when flying in challenging environments, such as deserts. Sand particles composed of calcium-magnesium-aluminum-silicates (CMAS) as well as sulfate containing industrial dust melt in the combustion chamber and leave deposits on the surface of the thermal barrier coating (TBC). The durability of modern combustor components increasingly depends on the performance of TBCs and Yttria stabilized Zirconia (YSZ) is still the established standard material for TBCs in the hot section of gas turbines.

Increased turbine inlet temperatures for better thermal efficiency however have already caused engine removals due to sand and dust pollution which result in premature coating failures. Molten CMAS infiltrates the open pores and micro-crack network of the YSZ thermal barrier coating, and a thermo mechanical and thermo chemical interaction between the molten CMAS and YSZ results in rapid coating damage. The affected combustor liners, especially in engines which are operated in deserts, cannot be repaired with regular weld or patch repairs but frequently have to be replaced due to excessive burning. This often leads to unscheduled shop visits. Additionally, CMAS attack results in a significantly decreased on-wing time compared to normal flight operation without environmental sand and dust pollution.

Airfoils

MTU Maintenance has a wide range of repair capabilities for cold- and hot-section airfoils. Tip welding, surface finish restoration, and coating applications for the cold-section airfoils are standard processes at MTU Maintenance.

Hot-section airfoils are exposed to extreme conditions during operation and are one of the most stressed components in a turbine. They must withstand excep-

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THIS IMAGE shows the different stages of larger, cold section fan blades repair. From left to right there are several stages of repair shown: from a damaged blade to the finished one.

tionally high temperatures and pressures. To make sure they perform reliably special repair techniques and treatments are needed. For these parts, MTU's repair services also offer a wide range of innovative technologies which may make the airfoils even more resistant to high operational stresses than virgin OEM parts are.

One such process is MTUPlus Tip Protection, an innovative technique for re-hardfacing worn tips of turbine blades. Another is MTUPlus Balance Stripping; during this process, each blade is continuously measured to determine exactly how much coating material must be removed. Through this stripping method, blades can be repaired three times during their service life instead of just once with a huge cost benefit.

In addition to blade repairs, MTUPlus Airfoil Replacement Technology ensures complete reparability of hot-section vanes. The optimized coating technology brings any damaged vane back into serviceable condition. Guaranteeing a zero scrap rate, this method avoids the necessity for cost intensive new material usage.

Combustor

The highest temperatures during engine operation occur in the combustor section. These extreme temperatures make it essential to protect combustor parts by using technologies and features such as thermal barrier coatings, including MTUPlus CMAS Resistant Thermal Barrier Coating as mentioned above and air cooling holes. To provide optimum heat protection, MTU Maintenance has developed unique and reliable repair processes for critical, highly stressed combustor components, with the aim of extending on-wing times. Some of these, such as weld section and dimple overhang repairs fully avoid material replacement. MTUPlus Thermal Barrier Coating applies the internally developed "Metco2460NS" to the inner and outer liner, which improves thermo-mechanical strength and is proven to avoid adverse spalling. In addition, increased isolation properties significantly reduce base material temperature.

INNOVATIVE SOLUTIONS FOR MATURE ENGINES

But MTU Maintenance is about much more than just repairs. The company stands out for a broad range of services which go beyond traditional engine maintenance and includes leasing and asset management. These solutions span the entire life cycle of an engine and allow customers to benefit from minimized operational and maintenance costs. MTU has developed solutions specifically tailored for operators, such as MTUPlus TEC®. This program is a comprehensive solution that goes beyond MRO to include related services on a modular basis such as spare engine support, fleet management and engine trend monitoring, on-site and on-wing services, and accessory and LRU management. The overall aim is to keep operations hassle free for customers. MTU Maintenance also has a mature engine program for operators of aging engines, which require frequent and costly shop visits with high material usage. Further, individually tailored products help maximize asset values through optimized end-of-life material and asset management. MTU says that because of its broad portfolio the company sees growth opportunities across all engine generations.

Mature Engines

MTUPlus Mature Engine Solutions programme is tailored to customer needs. The primary aim is to keep costs down for customers, which is achieved through cost-effective MRO alternatives (smart repairs) and alternatives to MRO (instant power solutions). Solutions are highly individual and customized according to the customer's fleet and engine needs. Furthermore, the amount of surplus engines and related surplus material available on the market through phase-outs increases the number of available options. MTU Maintenance's market knowledge and technical expertise put it in a unique position to achieve the best results for mature engines such as CF6-50, CF6-80C2, CF34-3, CFM56-3, PW2000, and V2500.

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GP7000
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CFM56
PW2000
PW6000
V2500
Business Jets
PW300
PW500
PW600
Turboprops
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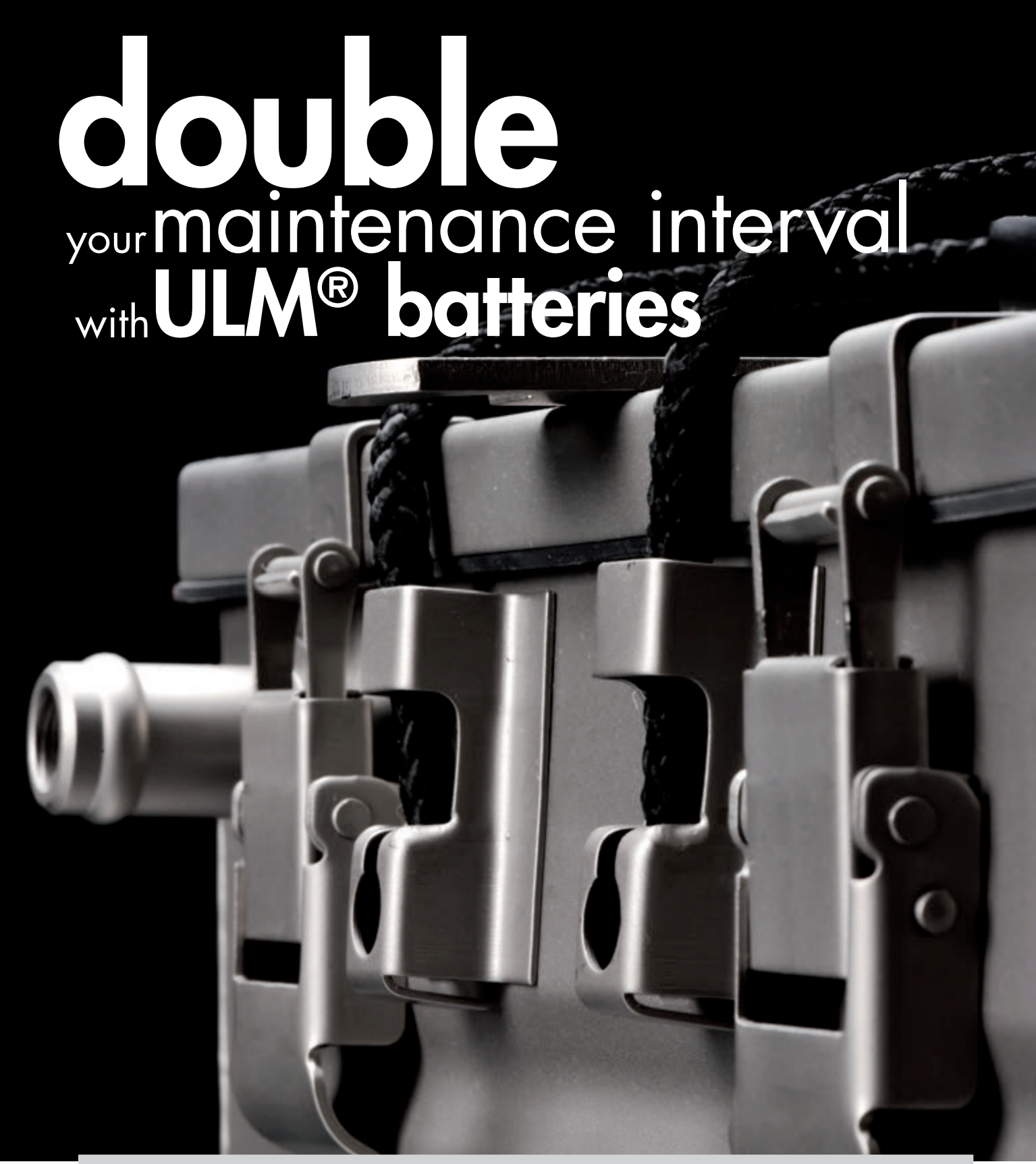

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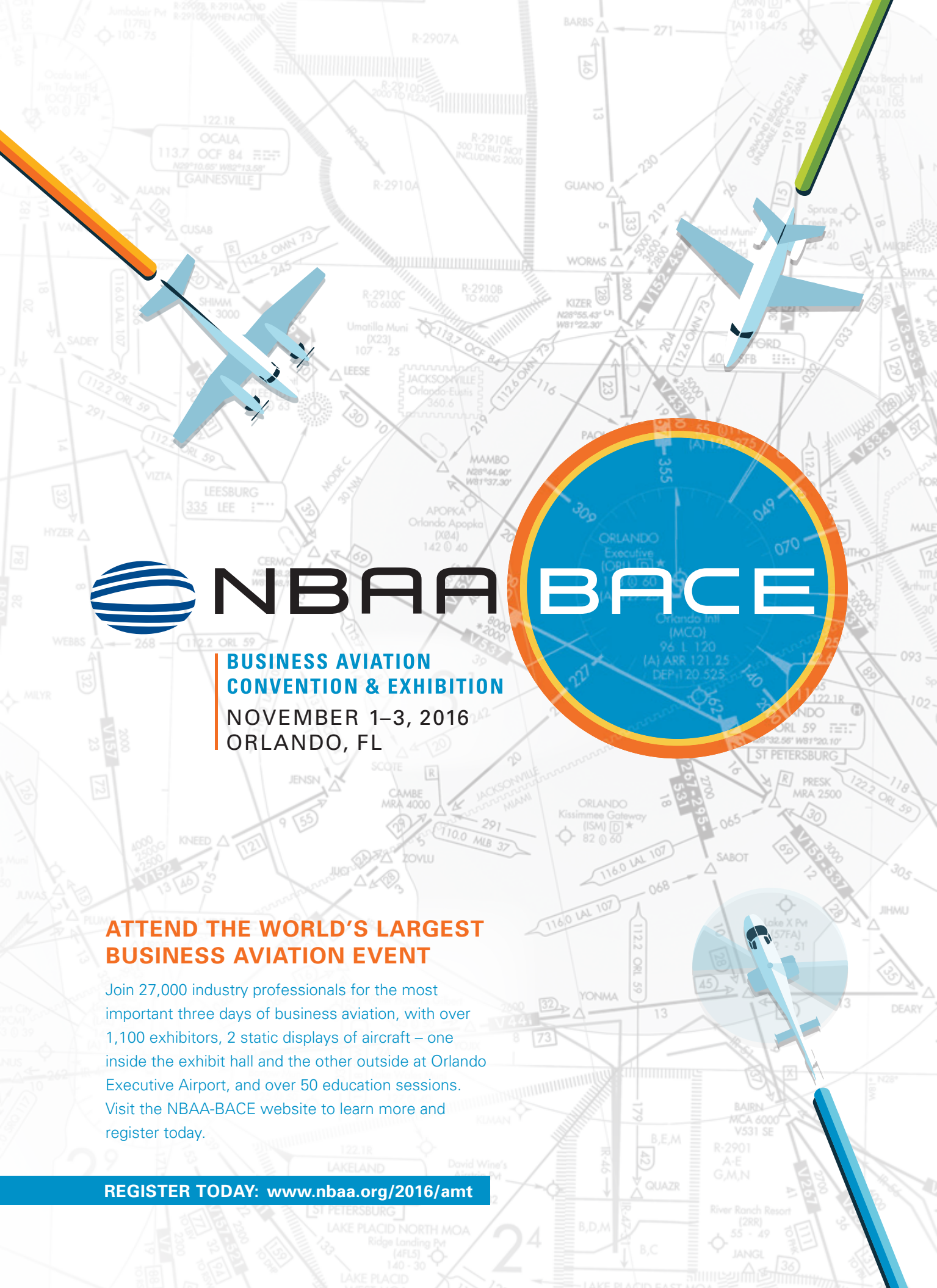
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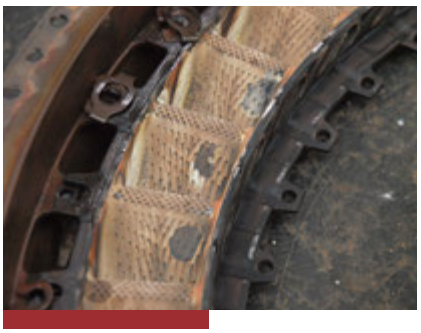
Current Generation Engines

In terms of narrowbody engines, MTU Maintenance sees growth in the CFM56-7 market and the engine will be more important in years to come as the shop visits have more than doubled since 2008. In 2015 shop visits for the CFM56-7 were well above the 1,000 mark and MTU Maintenance expects around 2,000 shop visits by the middle of the next decade.

In terms of widebodies, the GE90 will become increasingly important over the coming years for MTU Maintenance. There are currently seven full level MRO shops on the GE90, of which only four also perform work on the GE90 base. However, of those seven shops, there are actually only three shops that actively compete acquiring work on the third-party market, namely MTU Maintenance, Air France Industries, and the OEM. In the longer term and as the engine matures, MTU expects an increasing share of time and material contracts. This should occur when first OEM contracts are expiring and aircraft start migrating from first to second tier operators in larger numbers — at the latest by the end of this decade.



HOT-SECTION VANE as removed from the engine.

Next Generation Engines

Through its global locations network, MTU Maintenance is prepared for the new generation of engines. For example, the shop in Hannover, Germany, already has licensed MRO capability for the PW1100G. MTU Maintenance Zhuhai is also planning to step into next generation engine MRO in due time as its joint venture partner China Southern Airlines has ordered the new technology for the A320neo and the 737 MAX, as well as the locally built C919.

MTU Maintenance is also an OEM MRO network partner through its parent company MTU Aero Engines. MTU Aero Engines is a risk and revenue sharing partner (RRSP) for the V2500 and the GP7000, as well as for next generation engines, for example on the PW1100G-JM, the GEnx, and the GE-9X. ***AMT***

LIFE-LIMITED PARTS

Life-limited parts (LLPs) are among the most cost-intensive parts of an engine. MTU Maintenance offers a wide range of licensed high-tech repair processes for the entire spectrum of LLPs. In addition to OEM repairs, the company develops its own repairs for life-limited parts.

Recent high-tech process developments have opened up entirely new opportunities in life-limited parts repair. Integrally bladed disks, so-called blisks, for example, were initially considered irreparable and had to be replaced when damaged. Through the adoption of innovative technologies, MTU has succeeded in developing advanced repair processes to restore blisks to prime condition. Today, MTU is a global leader in blisk technology with sample programs including the PW300, PW500, CF34, PW6000, GE90, and the GP7000.

P&WC'S PREDICTIVE PRESCRIPTION

The most important word in the MRO lexicon these days just might be just be 'predictability.' It's certainly the driver at Pratt & Whitney Canada's engine operations

By Jerome Greer Chandler

ONGOING INNOVATION in the P&WC lab.

ALL IMAGES COURTESY OF PRATT & WHITNEY CANADA

There's a maxim in this business most preach, but not everyone practices. It's a variation on the theme 'service begins after the sale.' For Pratt & Whitney Canada, "Facilitating good maintenance at an affordable price," is the best of best practices says Tim Swail, the engine-maker's vice president of customer programs. It begets more [powerplant] availability, more predictability for the customer in their business environment.

The most important word in the MRO lexicon these days just might be 'predictability.' It's certainly the driver at Pratt's north of the border engine operations. "Our customers really are expecting us to deliver maintenance solutions that manage their business in the most predictive way they can," says Geoffrey Corbeil, general manager of P&WC aftermarket commercial aviation.

PWC focuses on four such solutions, one of them embryonic; the others at various stages of maturation. "There's really a common thread" that stitches them all together, asserts Corbeil. "Beyond the dependability of the [powerplant per se] is delivering guaranteed services."

Here they are: The Oil Analysis Technology Program, FAST, Eagle Service Plan and SMART.

The Oil Analysis Technology Program is one of the newest arrows in P&WC's quiver. Engine oil analysis, of course, is nothing new, it's been around for years. In written response to *AMT* questions, P&WC says its new system is "innovative … allowing us to assess — with a high degree of precision and detail — what's going on inside the engine without removing it, so we can diagnose issues sooner and potentially prevent events entirely."

Without delving too deeply in the weeds (and at the same time not divulging proprietary parts of the process) Swail contends, "We do something very different in monitoring the oil."

Traditional engine oil analysis relied on a technique called SOAP, or the Spectrometric Oil Analysis Program. P&WC insists its new approach is "much more sensitive than incumbent oil debris monitoring technology."

What Pratt's new initiative does, according to Swail, is triangulate the specific metallic alloys in the oil, drilling down to find from what component in the engine they come from. The effort is especially good at monitoring the health of oil-wetted engine components, things such as bearings, carbon seals, and various gears.

The end game, he says, is to "continue to bring a more planned environment to our customers — helping their maintenance costs and transitioning into a more planned environment. Hard, scheduled maintenance approach."

The next step in the end game as far as the oil analysis program is concerned is continuation of a critical clinical trial, one in which — at present — some 2,000 P&WC engines are registered. "We're actively recruiting [operators] and encourage" anyone flying P&WC engines to help form the statistical baseline says Corbeil.

"We're inviting customers to participate so that we have a number of engines across all our product families where we're collecting this information, says Swail. "We consider the analysis very well calibrated already. But [we want to] get out there and get an additional level of field data." As the program progresses P&WC plans to share the resultant data with customers, as well as the larger aviation community. The aim is to tell specific customers how the findings apply to them and their operations.

This is no mere academic exercise on Pratt's part. It's actionable intelligence. Evidence?

JEROME GREER CHANDLER is a two-time winner in the Aerospace Journalist of the Year competition's Best Maintenance Submission category; he won in 2000 and 2008. His best-seller 'Fire and Rain' chronicles the wind shear crash of Delta Flight 191 at DFW. Chandler's passion for aviation safety is more than professional. It's personal. Two of his relatives have perished on commercial airliners, one of them in the infamous Braniff Electra crash of 1959.

"We absolutely have cases already where we've been able to advise a customer to schedule maintenance, or to keep a customer flying. This clinical phase," contends P&WC's vice president of customer programs, "is going to take us to the next level."

Data is to be collected over the next 12 to 24 months.

"We know a lot now, and we can put it to good use. We've given ourselves a set of objectives built around maintenance costs and [aircraft] availability," says Swail.

There's no cost to customers to participate in the oil analysis effort. The process revolves around a pre-packaged kit. Take your own oil sample. "We'll send it" to one of two analysis centers, he says. If you'd like to participate in the program as an early adopter, contact your P&WC field support representative (FSR). Once in, follow a simple four-step process:

1. Collect an oil sample every 100 to 500 hours, depending on the engine model;
2. Ship a sample to P&WC in a prepaid envelope;
3. Wait for word on the analysis;
4. Receive a summary report on the analysis' findings.

An important note: this program in no way replaces existing requirements in your current maintenance program. As always, follow the EMM's (Engine Maintenance Manual). If you want some clarification on an issue, as always, contact your FSR or email P&WC at oil.technology@pwc.ca.

The oil analysis effort is exciting stuff, but it's not all that's going on at Pratt. Consider:

FAST (FLIGHT ACQUISITION STORAGE AND TRANSMISSION)

First rolled out back in 2011, the turnkey engine diagnostics and prognostics program is now installed in more than 580 aircraft. This includes the aircraft of 20 regional airlines. What now seems commonplace was once cutting-edge. Such are the ways of technology.

FAST analyzes and shoots off in-flight data to customers within 15 minutes of landing. The idea is to get ahead of the operational power curve when it comes to dispatch and maintenance — as well

TECHNICIAN WORKING on a PW119 engine on wing.

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as cutting operating costs.

Linking FAST conceptually with Pratt's new oil analysis approach is the age-old concept of listening, "listening to the engines — whether it be from the oil sampling or the data that we pull off a flight recording and various parameters," says Swail, "and, getting information from customers about how well the engine's performance is trending, how specific components are faring so that we can get recommendations to them in advance about a problem that might cause a delay or cancellation."

TECHNICIAN WORKING on a PT6.

He says the new oil analysis technology and FAST solutions are really part of the set of diagnostics, prognostics, and health monitoring that continue to evolve.

Pratt possesses a pair of evolving sales and marketing-based initiatives too. Both are designed to infuse the process with more predictability.

The engine-maker is introducing a new twist to its **pay-per-hour ESP** (the Eagle Service Plan) initiative. It provides gratis maintenance coverage for the first 400 hours for new PT6A powerplant. The venerable PT6 line has been around for half a century now, just having celebrated its 50th birthday last year.

Finally, there's **SMART** — more specifically upgrades to the fixed-cost pricing program. Enhancements to the PT6A, PW100, and turboshaft engines now are in play. PW&C says, "There are now 25 SMART solutions and growing." The company is tailoring SMART solutions to

P&WC'S CFIRST Center

its product lines, offering more pricing options on more powerplants, says Swail. "On certain planes we're simply a capped cost or controlled cost for an overhaul or hot section. Facilitating good maintenance at an affordable price just leads to more availability, more predictability for the customer and their business environment."

Indeed, in the industry as a whole, after-sale maintenance and marketing solutions help build layer upon layer of mechanisms designed to take some of the guesswork out of this precise business called MRO. ***AMT***

WHAT ARE THE **CORE COMPETENCIES** FOR AIRCRAFT MAINTENANCE?

Our profession is one that will always require a level of proficiency with tools. There will always be a need for skilled craftsmen and preserving the tribal knowledge, but just what tools will technicians of the future be required to master?

By Jim Sparks

JIM SPARKS has been maintaining aircraft for almost 40 years with the majority of the time involving Business Aviation activities. Jim's endeavors have placed him on six of the seven continents contending with numerous situations from routine flight dispatch to critical AOGs. His career includes maintainer, avionics/electrician, educator, tech rep, and director of aircraft maintenance. In addition to other activities he is engaged with ASTM assisting in the global development of criteria defining the Next Tech for NEXTGEN. You can reach him at sparks-jim@sbcglobal.net.

The ability to accomplish any endeavor successfully and efficiently is often considered part of the unwritten job description for those of us involved in ensuring airworthiness for the global aviation community. Traditionally we have been a task-based profession benefiting from instructor-led training then becoming proficient at our jobs through repetition and in all likelihood that tradition will live on.

In the United States, Federal Aviation Regulations in Part 147 was created in the 1960s and provided direction for institutions conducting initial training for our nation's Airframe and Powerplant (A&P) mechanics. At the time, knowledge requirements were very much in-line with the technology employed and many of the aircraft then in service had military origins. A high percentage of the rank and file employed by airlines as well as airframe manufacturers received their indoctrination to aviation maintenance in various branches of the armed forces and back then the skills required were clearly defined and could for the most part be demonstrated and practiced as part of the A&P school curriculum.

Have the basic skills really changed or just possibly evolved? Structures were manufactured using aluminum alloys concocted and heat treated to provide high strength at a low weight and we were tested on cutting, bending, utilization of special fasteners, and applying anti-corrosion products. In addition significant time was spent accomplishing fabric recovering and associated repairs. We even dabbled with composites. Of course back then it was nature's composite otherwise known as wood and I still remember doing a scarf splice on a mockup of a wooden spar. Radial engines were still widely used and turbine technology had recently revealed the value of fan jet engines.

Our training covered the Brayton cycle and at least some of the theory associated with hydro-mechanical fuel control units. Avionics training was part of the program and consisted of lectures on radio theory, navigation instruments including gyros, pitot static systems, and autopilot principles. Radar was even mentioned with the caveat that it's best to leave that system to the specialists due to the probability of emitting large amounts of radiated energy. The program culminated with the assignment of a project to build an analog multi-meter from a kit. Electronic calculators were just finding their way into the hands of the general public and I recall one of my instructors commenting that calculators would never find their way into aviation.

WHAT IS NEEDED FOR SUCCESS?

It is globally recognized the aviation maintenance profession is in dire straits with the worldwide fleet of aircraft growing at a rapid rate, numbers of new technicians entering the field have diminished, and those of us actively engaged struggle to keep up with ever-evolving technology. So what are the core competencies needed to achieve success today and in the future?

Several industry groups have undertaken initiatives to ensure our profession continues to evolve in a manner consistent with technology advancements. ASTM International is currently develop-

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ing global standards defining what aviation personnel need to know. In addition the Aircraft Electronics Association (AEA) has worked to define the core competencies required to become an aircraft electronics technician (AET). The Aviation Technician Education Council (ATEC) has also worked directly with the FAA to update the outdated A&P training curriculum.

The U.S. Department of Labor and Statistics comprises data regarding injuries and fatalities related to various professions. For a number of years pilots have ranked within the top 10 high risk jobs. The aviation maintenance profession has fared much better. Nevertheless, safety practices and dealing with hazards is a paramount competency.

Aircraft damage as a result of **foreign object ingress** is still a leading cause of delayed or cancelled flights along with significant associated costs. Foreign object damage (FOD) has traditionally been associated with items ingested into engines or possibly causing damage to aircraft tires. Aircraft wiring has been subject to FOD over the years and has resulted in several noteworthy incidents.

A fairly recent concept known as **electrical wiring interconnect systems (EWIS)** has been adopted by numerous airworthiness agencies including the FAA and EASA. Part 25 of the Federal Air Regulations (FAR) addresses Transport category aircraft and section 1701 introduces EWIS as a requirement for new aircraft. The concept involves selection of appropriate wire type, routing, separation, and segregation of wires dealing with different transmissions such as power feeders and digital data buses. It also addresses clamping and securing by different means and most importantly covers means of ensuring continued airworthiness. Advisory Circular 25-1701 provides guidance on EWIS fundamentals and the FAA web site has several training programs to help educate technicians on the critical importance of proper aircraft wiring.

Electrostatic discharge (ESD) is a well-known phenomenon in aviation. Most technicians are aware of the importance of properly placed and maintained static dischargers on external airframe surfaces. FAA studies indicate that on average each aircraft takes a lightning strike once a year. Usually harmless, however when proper electrical bonding isn't intact a lightning strike can be very detrimental.

It is essential for technicians to understand the effects static electricity can have on sensitive electronic circuits. It has been reported that up to 40 percent of reported equipment failures can be attributed to some type of induced ESD. Several avionics manufacturers have developed educational programs to increase ESD awareness and have even altered equipment warranties denying claims if the fault is likely caused by ESD.

Well-intentioned and experienced aircraft technicians will make mistakes making **risk management** practice essential. Knowledge, understanding, and adherence will prevent common errors. Understand the safety hazards associated with human fatigue and strive to eliminate them. Fatigue has been linked to forgetfulness, poor decision making, and reduced attention that can interfere with the ability to do the job safely. Pay attention to the safety and security of the items that undergo maintenance and any surrounding components that may have been disconnected or loosened during maintenance.

Carefully assess **manufacturers' maintenance instructions** and question when something either doesn't work or doesn't make sense. Most aircraft manufacturers have support organizations with first-hand experience to clarify questionable processes or procedures to ensure that the work is completed as specified. Always refer to up-to-date instructions and manuals when performing a task, and ask questions of another qualified person if something is unfamiliar. A second set of eyes is always desirable to validate the functionality, safety, and security of critical items that have been touched. Thoroughness when performing routine inspections and recognizing items requiring immediate attention means items are addressed rather than deferred.

TOOLS OF THE FUTURE

Our profession is one that will always require a level of proficiency with tools. There will always be a need for skilled craftsmen and preserving the tribal knowledge associated with devices such as the English Wheel, but just what tools will technicians of the future be required to master?

The list will probably include many devices currently in use such as both analog and digital multi-meters with the ability to recognize when to select one over the other. Oscilloscopes and/or scope-meters are also a necessity to ensure success in the predominantly digital environment found in today's aircraft. It will be important to understand the design philosophy of maintenance diagnostic computers and their role of being troubleshooting tools — not always spelling out a solution but pointing you in the right direction. Most important is the knowledge and understanding of the soft skills such as the role of communications and interaction within a team to get the job done safely and the aircraft airworthy. **AMT**

"I recently worked with Elliott Aviation on a Citation interior project and had an excellent experience. I had heard they had an excellent maintenance shop but I was skeptical about their Challenger 300 experience. I took the time during my Citation work scope to get to know Greg Feuerbach and Andrew Nicewanner, who both have exceptional Challenger 300 experience. I awarded them my 96 month inspection and the planning, communication and quality of workmanship was excellent. The aircraft was delivered on time, squawk free and was one of the most painless major inspections I ever had on my aircraft."

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SAFE DESIGN AND HANDLING OF LITHIUM-ION BATTERIES IN AIRCRAFT

Lithium-ion battery technology is rapidly making its way into use as a primary power source for aircraft. How much is really known about the chemistry, design considerations, and safe servicing and handling practices

By Ronald Donner

LITHIUM-ION BATTERIES HAVE BECOME THE preferred source of electrical power for numerous consumer products that we use each and every day. I'd guess most of us have one in our pocket right now – that would be your cell phone.

Lithium-ion batteries have been a significant part of aviation for the past decade. Applications have been used in systems such as avionics backup power supplies, emergency lighting, ELTs, powering auxiliary equipment (crew cabin phones, cabin doors), uninterrupted power systems (UPS), and engine start batteries for fighter jets and drones.

Lithium-ion technology has made its way into engine-start batteries for general, business and air transport category aircraft. This technology has further evolved and FAA Supplemental Type Certificate (STC) installations for lithium-ion engine-start batteries on various aircraft will be a reality in the near future, and the list of aircraft flying lithium-ion batteries is sure to grow rapidly over the coming years.

TRUE BLUE Power battery installation in a Bombardier Dash 8. TRUE BLUE POWER

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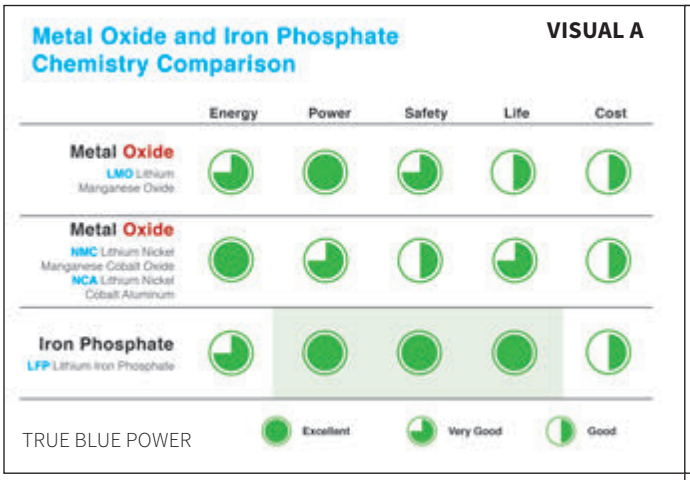

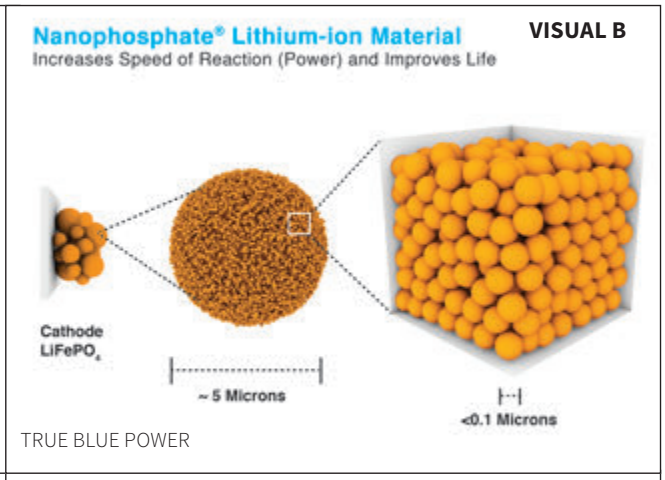

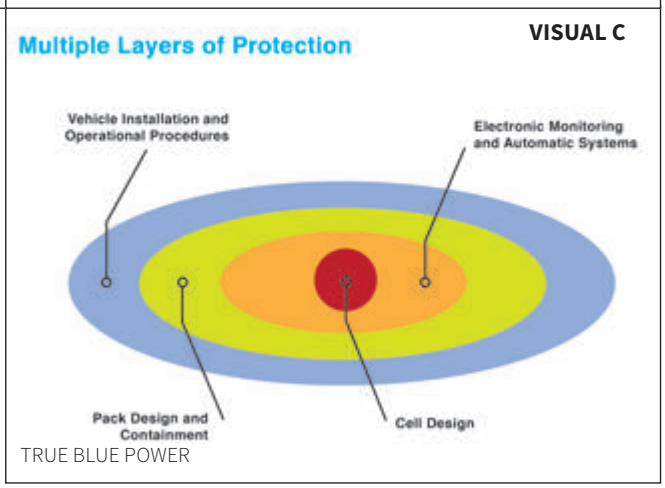

Wanting to know more about lithium-ion batteries, I attended a seminar by True Blue Power during EAA AirVenture Oshkosh in July, and later spoke with them to learn more about the technology.

THE CHEMISTRY

First, a few common lithium-ion chemistries are used today. Each of these chemistries has uniquely different characteristics relating to energy, power, safety, and life span.

Metal Oxide. Lithium Manganese Oxide (LMO)

Metal Oxide. Lithium Nickel Manganese Cobalt Oxide (NMC) and Lithium Nickel Cobalt Aluminum (NCA)

Iron Phosphate. Lithium Iron Phosphate (LFP)

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True Blue Power has selected Lithium Iron Phosphate, more specifically Nanophosphate lithium-ion chemistry. Nanophosphate® lithium-ion chemistry is proprietary to A123 Systems LLC. It differs from standard Lithium Iron Phosphate and other lithium-ion technologies. The small (nanoscale) material is engineered to maximize the performance of lithium batteries.

Nanophosphate Lithium-ion material increases the speed of reaction (power) and improves life. It provides a higher rate capability and power than standard Lithium Iron.

Phosphate, delivering smaller and lighter pack size. Additionally, it offers greater safety and abuse tolerance compared to Metal Oxide Lithium-ion chemistries.

This chemistry has high calendar and cycle life with consistent performance over extended use periods. It has low self-discharge rate over time and higher usable energy.

SYSTEM DESIGN CONSIDERATIONS

Like any new technology the design is where it all begins. According to Rick Slater, True Blue Power director, "Following these four criteria when engineering the design of a lithium-ion battery system is very important."

Monitor

- Use of intentional circuit design and logic to measure real time cell and system parameters

Manage

- Based on evaluation of real time data, modify or adjust run-time parameters within the product or system to provide optimal balance of key elements or values (Example: Cell balancing within a module)

Mitigate

- If measurement data exceeds certain boundaries or limits, initiate actions to limit or shut down functionality (Example: Controller takes battery module offline if temperature is detected over specific limits)

Contain

- Container construction plus venting apparatus are designed to contain and control the effects of a "worst case" event

Lithium-ion battery systems should include a battery system status (BMS) to monitor and report parameters such as voltage,

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BEST PRACTICES FOR SERVICE, SAFETY AND HANDLING

The two most important factors for maintainers, operators, and handlers of lithium-ion batteries are: fully understand the chemistry type and technology and follow all of the instructions provided by the manufacturer. Slater goes on to say, "Operators and handlers should establish specific servicing and handling procedures for their operation and understand and follow all safety requirements and handling recommendations."

True Blue Power recommends the following:

SERVICING

- Charge lithium-ion batteries when received, as they are shipped at less than 100 percent state of charge (SOC)
- Capacity check every 24 months thereafter
- Charge a lithium-ion battery if left unused for six months
- Charge a lithium-ion battery with constant potential
- A lithium-ion battery can be charged on the aircraft

According to True Blue Power, its batteries do not have to be removed from the aircraft and routine capacity checks can be completed without having to send the battery to a certified battery shop with specialized equipment.

Many of the typical tools and equipment used to service more traditional battery types are not needed to service lithium-ion batteries.

A computer or laptop loaded with specific software connected to the battery with a connector cable is needed for the 24-month capacity check of the True Blue Power 46-amp hour battery. For some of their batteries an ARINC 429 data reader can be used to aid in any troubleshooting.

STORAGE

- Do not store a lithium-ion battery greater than six months without recharge
- Avoid more than seven days without charging a lithium-ion battery if fully discharged
- Do not keep in areas with highly flammable materials

GUIDELINES FOR OPTIMUM LITHIUM-ION BATTERY LIFE

- Maintain 0 to 28 C. (32 F-82 F.) shelf storage environment (optimal)
- Maintain 20 to 80 percent state of charge (SOC)
- Charge within temperature specifications — chemistry dependent
- Conduct high current operations with > 80 percent SOC

CONDITIONS TO AVOID WHEN OPERATING OR HANDLING LITHIUM-ION BATTERIES

- Excessively high temperature
- Excessive voltage or excessive current
- Excessive discharge below battery limit
- External or internal short circuit

TRUE BLUE POWER

IN THE True Blue Power lab.

temperature, state of charge and health, maintenance notifications, and an automatic protection system for shut off of excessive charge or discharge conditions.

Lithium-ion batteries should feature a ruggedized case for optimum protection of components and containment of materials in case of a failure event. The system needs to also include an integrated venting system for extraction of gases and/or debris in case of internal failure.

The installation environment on the aircraft needs to be considered. Factors such as the temperature near the battery location, location in or near fluid zones, and the potential for excessive physical abuse of the battery or system are a few examples of factors to consider during an installation.

CONCLUSION

There have been some high-visibility events relating to lithium-ion battery systems. A search of the worldwide web will result in hundreds if not thousands of articles, notices, product reviews, and yes opinions on the use of lithium-ion batteries in aviation. This can lead to perceptions and even misinformation. With any new technology there are challenges and unknowns.

There are many companies actively conducting research and development, producing lithium-ion batteries, and working to provide the aviation industry with safe applications for aircraft.

This article is not meant to debate the pros and cons of this technology in aircraft, but to pass on a few points of interest I learned from one company involved with this technology.

Anyone considering or already operating, maintaining, or handling lithium-ion battery systems, needs to fully understand the chemistry type and technology and of course follow all of the instructions provided by the manufacturer. Clearly, educating yourself on this technology is very important. **AMT**

Information and images used in this article were provided by True Blue Power. For more information visit www.trueblue-powerusa.com.

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CONTINENTAL

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STORYTELLING TIPS: HOW TO IMPROVE YOUR HANGAR TALK AND WAR STORIES

By Dr. Bill Johnson

JUST A few books about speaking and storytelling.

DR. WILLIAM B. JOHNSON is the FAA Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems. His comments are based on nearly 50 years of combined experience as a pilot/mechanic, an airline engineering and MRO consultant, a professor, and an FAA scientific executive.

ALL AVIATORS HAVE STORIES TO TELL. PILOTS may talk about episodes of near fuel exhaustion while mechanics talk about fuel leaks or electric fuel pump wiring. Did you every wonder if your stories are good enough? How do your stories measure up with the excellent aviation tales that you have heard from others? Faced with the dubious task of teaching experienced Aviation Safety Speakers about storytelling, Johnson went to literature to gather tips for storytelling. He believes that he has improved his stories. He conveys selected tips here. Use the tips as a checklist to evaluate and improve your tales.

THE TOUGH TASK

In August of 2016 I had to teach FAA Aviation Safety Inspectors about storytelling. The event was a Human Factors Train-the-Trainer workshop (See September 2016 *AMT* Magazine for the workshop details). With 50 years as a pilot and almost as many as an AMT I have many stories that I have told and retold. But as I prepared to teach/refresh others I became introspective about my storytelling delivery and content. I asked myself questions like: Did my story keep the listeners' interest? Did I use the words and gestures to help the listener visualize the story? If it was a "Dark and Stormy Night" did I describe it appropriately? Did the story have a take-away message? Would someone choose to retell my story? Did it have value to the listening audience? Questions like these rocked my confidence as a public speaker. The solution to my instructional development and storytelling challenge was in the literature. My learning process and subsequent book buying was a good day for Amazon book sellers.

STORYTELLING GUIDANCE

Perhaps the very best way to improve and master your storytelling technique is to recall the best stories that you have heard or read. Those stories may have been told by a relative, a friend, a teacher, or a minister. Try and recall the reasons why you remember the story. Can you integrate that style into your existing or new story?

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SATAIR

Make the story a journey. Be sure you know what you are trying to achieve. Your tale should have an obvious beginning, middle, and end. Usually the story builds to an end that evokes emotion and learning.

Another way to hear good stories is to watch famous speakers. During my July 2016 studies of storytelling I was fortunate to have two U.S. national political conventions on nightly television. Watching those speeches was a like a college course in storytelling. Most of the speakers had a catchy start, some good information along the way, and then a strong closing that tried to convince me to vote for their candidate. Agree with them or not, the best speeches helped reinforce the best traits of storytelling. Most of the speeches were short and designed to get across a single message. Of course, the nominated candidates' speeches were long, by tradition, but highly choreographed (aka, teleprompter).

These days the internet will let us visit all the great speeches. We can observe President Kennedy saying: "Ask not what your country … but what you can do for your country." We can watch President Reagan, at the Berlin's Brandenburg Gate telling the Soviet Union President "Mr. Gorbachev, tear down this wall." The internet also permits us to watch the powerful Technology, Entertainment, and Design (TED) talks to tickle our intellect and emotion.

And there are books and magazines, a lot of them. I went to books about TED Talks (Ted Talks Storytelling, Akash Karia, 2015) to books by comedians like Margot Leitman (Long Story Short, 2015). The term "too many to list" applies here. Just "Google it (storytelling)".

THE ADVICE CHALLENGE

There are many storytelling techniques that are generally agreed upon. There are many opinions regarding dos and don'ts. For example, "keep the story short" vs. "provide details". Some say that standing up is likely the best way to deliver a story. Others suggest that you can sit down to tell a story.

Therefore, you must use a multitude of sources to learn about storytelling. Then, as a storyteller, you must decide what works for you and your audience.

The following checklist offers 11 tips for storytelling. There could have been five or 50 but 11 are enough. These tips come from a number of writers but I must acknowledge that Akash Karia is most followed here. I am convinced that the tips have improved my best stories. Try your story and see how many you apply.

CHECKLIST FOR STORYTELLING

1. **Your enthusiasm is critical.** If you are not enthused about your story then don't expect the listeners to be. Your enthusiasm is transmitted from the moment you are seen by the listener. Your physical demeanor, before you open your mouth, is critical. Watching the political convention speeches made this very apparent. Know the audience. What you say to a small group of fellow mechanics is very different than speaking to a room full of regulators, or to your daughter's class. Talking to a group at an Inspection Authorization renewal is very different than talking to a group of organized labor AMTs. When you know the audience you can tell stories and about life experiences that they can relate to.

Eugene Cernan, the "Last Man on the Moon," tells stories of an adventure that few will have. His story is great because he relates to the audience by describing growing up on a farm, working hard on the high school football team, studying to the best of his ability in school, deciding to join the U.S. military, and finally fingering his daughter's initials on the face of the moon. Sure, he has a great story. But, he knows how to tell it.

2. **Start strong.** Most of the books agree that you win or lose the audience in the first minute. I think of the Nicolas Cage car stealing movie "Gone in Sixty Seconds." That's how fast you lose audience attention. You are unlikely to recover.

3. **Not stand-up comedy.** A story may have funny moments but don't feel that a story must be stand-up comedy. Leave that to the professionals.

4. **Stories should be true.** False stories are lies. Saying it's fictional may help.

5. **Stories can be embellished but it is a slippery slope to a falsehood if not careful.** In 2015 newsman, Brian Williams, was admonished for embellishing a story about a helicopter event while covering the war in Iraq. He never fully recovered his reputation.

Mark Twain is attributed with saying: "If you tell the truth you never have to remember anything." Although some attribute Twain to the quote: "Never let the truth get in the way of a good story." Of course, Twain (aka Samuel Adams) commented on the false report of his death, "The reports of my death are greatly exaggerated."

6. **Tell positive stories.** In aviation especially event investigation, the stories can include high death counts with associated unpleasant visions. However, there are a lot of close call events that can make the same safety points. Talk about close calls where a mechanic discovered a leak or crack or when the pilot makes a safe emergency landing.

In August 2016, there were number of errors that led to the crash landing of an Emirates B777. Everyone escaped the burning aircraft. The explanation of wind shear, flight deck decision making, and following emergency flight deck procedures is the same as if the evacuation was unsuccessful. But the ending was good news.

Another example of a good news story is the 2001 Air Transat A330 over the mid-Atlantic ocean, near the Azores. A misrouted fuel line broke and then poor fuel management procedures resulted in total fuel exhaustion. All survived the long overwater glide and safe dead-stick landing.

7. **Make the story a journey.** Be sure you know what you are trying to achieve. Your tale should have an obvious beginning, middle, and end. Usually the story builds to an end that evokes emotion and learning. If you can't achieve that, then consider another story.

8. **Paint a picture.** Akash Karia encourages the story teller to try to create a mental movie. Provide enough detail for the listener to imagine the scene and the characters. When you describe a person or a place try and touch on as many of the five senses as possible. For example: The floor of the hangar was a bright sparkling white epoxy, so new that you could smell it. While there were mechanics working on various repairs, on the midsize corporate jets, the noise level was low because of the sound-absorbing walls. When I met the director of maintenance his firm hand shake and eye contact ensured me that they could help me with the avionics installation on my aircraft. In those few sentences we address four of the five senses. The story is proceeding well.

9. **Use props.** Any AMT remembers the classes where you passed around worn parts, pistons with holes, fried wires, or frayed cables. It's good to use such props when possible. Today, the internet provides props but 3-D props prevail. I recently told the story of a person that I met at a meeting. While I described him I held up his business card. The card was a prop and made the character more real and it helped the story.

10. **End strong.** The ending should provide a solution to any of the challenges that you may have introduced to make the story interesting. Try to limit the number of take-away messages. Keep it simple so that listeners will remember it. If the story has a moral be sure that the story tells it and you can spare: "The moral of the story is …."

11. **Practice, practice, practice.** You know your story. That's why you are telling it. But, rehearsal is important. You may be able to decide when to change tone or volume. You can practice your gestures and adjust your body language in front of a mirror or your telephone video camera. Once you rehearse enough your actions and words become automatic. Rehearsal also helps get your timing right. If the planners give you 30 minutes they don't want 15 or 45.

THE TIPS WORK

I have found the tips and advice to be useful. The tips have not caused me to eliminate stories but it has improved the stories in my repertoire. That's my story and I am sticking to it. ***AMT***

ACCIDENT VS. INCIDENT

Title 49 of the Code of Federal Regulations Part §830, 830.2 helps one understand the differences between an accident and an incident

By Stephen Carbone

My grandson, Ethan, came in the house wearing a wry smile and spoke in some cutesy, grammar-starved fashion, "I hads a accident with your car." Translation: he ran his Big Wheel into my commuter-mobile's rear tire. I was Ear-i-tated! No, no, I was pretty damn mad! "Did you sustain any substantial damage?" I asked. His eyebrows rose as the smile vanished. "You look OK; any serious injury?" His eyes widened and the jaw dropped. I was going for the jugular when his over-protective mouthpiece, that pre-school enabling enemy of common sense — Grandma, stepped in front and diffused the event.

Kids, they think they know everything!

Ethan should have read Title 49 of the Code of Federal Regulations Part 830, §830.2; it helps one understand exactly what an accident is. I keep a copy next to "The Cat In The Hat" and the other bedtime stories — sleep-inducing gold. These regs specifically state the differences between an accident and an incident. For those with an FAA mentality, the Flight Standards Information Management System (FSIMS) 8900.1 Volume 7, Chapter 1, Section 1, 7–4 General (A) Definitions lays the topic out in layman's terms. Either way, keep one handy for just such an emergency.

STEPHEN CARBONE is an avid writer of aviation fiction; his first novel *Jet Blast* has appealed to mechanics, pilots, air traffic controllers, etc. by giving accurate depictions of the accident investigation process. A former airline mechanic, he has been involved in many aspects of commercial aviation and went on to investigate major aviation accidents for the NTSB. A member of ISASI, Stephen holds a Master's degree in systems safety from ERAU. His weekly blog can be found at: http://jetblast.tateauthor.com

ACCIDENT

"An aircraft accident is an occurrence associated with the operation of an aircraft that:

- Occurs between when the first person boards the aircraft — with intention of flight — and the last person disembarks;
- Results in death or serious injury;
- Causes substantial damage to the aircraft."

Intention of flight means just that: somebody's punching holes in the sky. If mechanic Karen is performing a phase check task card and she falls out the entry door — incurring a serious injury — it's not an aircraft accident. But if flight attendant (FA) Todd, while prepping the cabin, accidentally blows the slide and himself with it, out the same entry door — incurring a serious injury — that's an accident. Why? Because FA Todd was the first person to board with intention to fly.

Death is self-explanatory. So what is serious injury? It is explained as "an injury that: requires hospitalization for more than 48 hours, within seven days of event; results in bone fracture(s) — except nose, fingers, or toes; causes severe hemorrhages, nerve, muscle, or tendon damage; second or third degree burns over more than 5 percent of the body; and/or internal organ damage." If FA Patty, while conducting beverage service, is seriously injured during turbulence, the event is an accident.

Now let's say mechanic Mike is taxiing the aircraft to the gate for a pending flight and shears the outboard elevator off — incurring substantial damage — it's not an accident; no intention to fly. But if pilot Carol buries a slat into an entry stand while taxiing into the same gate — incurring substantial damage — she's had an accident, because the last person hasn't disembarked from the flight.

Substantial damage is: "damage or failure that adversely affects the structural strength, performance, or flight characteristics of the aircraft and would normally require a major repair or replacement of the affected component." So pilot Carol's slat, engine ingested foreign object damage (FOD), and punching a hole in the pressure vessel — on an aircraft with intent to fly — each qualify for substantial damage.

Exceptions to the substantial damage rule are: "engine failure or damage limited to an engine; bent fairings or cowling; dented skin or small punctures in skin or fabric; ground damage to rotor or propeller blades; and/or damage to landing gear, wheels, brakes, flaps engine accessories, or wingtips."

INCIDENT

But what about an incident? Plainly stated, "an aircraft incident is an occurrence — other than an accident (no intention of flight) — associated with

the operation of an aircraft that affects or could affect the safety of operations."

Let's put these conditions into practical examination. United Airlines Flight 232, a DC10 that crashed in Sioux City, IA, on July 19, 1989, suffered an uncontained No. 2 engine failure. Did it start out as an accident or incident? The first half-second of the event began as an incident because of the substantial damage exception: engine failure or damage limited to an engine — if it remained an engine failure. However, the next half-second determined the event, an accident. Once the compressor blades penetrated the engine casing and sliced open the three hydraulic systems' hydraulic lines, it was, from that moment on, an accident.

That fact may seem trivial; after all, 111 people were killed … in that very real accident. But my point is to examine what constitutes an accident or an incident. And with that clarification, what needs to rise to the level of NTSB or FAA investigation and which can be limited to an air operator's in-house investigation.

My playfully introducing my grandson into the article demonstrates the news media's childish ignorance of our industry and what they write about. A captain dies of a heart attack, and the First Officer 'miraculously' lands the plane at the next airport. An engine fails in flight and the entire cabin finds religion for a 'harrowing' 15 minutes. An airliner blows a main tire on rotation and the passengers scream for a Congressional hearing into tire ply safety.

Naturally the first officer lands the plane; he/she has been trained; the event is called an accident only because someone died during the flight. A tire failure or a contained engine failure — both considered incidents — are unfortunate, but they happen. There's no call for panic.

The news media should focus on real threats to safety, e.g. amateur unmanned aerial vehicle (UAV) operators. Frequent airline reports of near misses with UAVs on approach is call for panic — major panic, for there's no control. These amateurs' irresponsible behavior around helicopters, airliners, and GA makes Ethan look like an adult by comparison.

The main difference between accidents and incidents is intent to fly. We, in aviation, always have the intent to be safe; yet we still — occasionally — have accidents and incidents. What if one's whole intent is to play chicken with aircraft? We most likely get substantial damage, serious injury … and death. **AMT**

HOW TO TRAIN IN OTHER CULTURES IN THE AVIATION INDUSTRY

Every country or region has its own culture and protocol for doing things

By ServiceElements, Christine Hill

Training is the backbone of the aviation and aerospace industries. English is the mandated international language of aviation. Aviation personnel, or at least pilots, flight crews, and air traffic controllers, must pass a proficiency in English. Applicants not only must know appropriate aviation terms in English, but they must also be able to understand instructions via radio in English, with no facial or body language cues to prompt them. Although this requirement is in place and this is a *similarity* that aviation professionals may share across the globe, there is a large amount of *diversity* in aviation training needs.

The impact of globalization, **compels nations, businesses, and people to step outside their local communities and cultures** to work with people who do things an entirely different way.

The aviation and aerospace industry in itself makes the world seem a much smaller place just due to the nature of the services provided — making it easy to do business in any location in the world. This along with the impact of globalization, compels nations, businesses, and people to step outside their local communities and cultures to work with people who do things an entirely different way.

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ServiceElements has been facilitating organizational and personal development training workshops in business and general aviation/aerospace for 15 years both in the U.S. and internationally. The international audience 15 years ago was interested in learning service expectations of the most elite customer base (of business/general aviation). But as business/general aviation is growing in other countries, there is a growing demand for learning how to deal with and relate to a variety of cultures.

DIFFERING CULTURE AND PROTOCOL

Every country or region has its own culture and protocol for doing things. Many times a country has different regions and each has their own culture as well. One unintentional miscommunication could destroy costly international business relationships.

Organizations from other countries are very interested in training to get a better cultural understanding of the U.S. We have conducted workshops in South and Central America, Europe, and the Middle East. There is always an eagerness to learn and understand the U.S. culture. Even when some of the aviation professionals (maintenance professionals, line service personnel, customer service reps, etc.) are not fluent in English (sometimes we use translators), they are very interested in the perception and expectations of the U.S. customer.

A study of cultural orientation gives us a model for understanding and predicting the results of intercultural encounters. **A good training program addresses those subtle and sometimes invisible differences between cultures.**

Organizations in the U.S. may be a bit more hesitant at 'training' their teams in cultural orientation. But we feel it is imperative for business and general aviation professionals in order to stay at the 'top of their game' in serving international clientele/passengers/aircraft owners. A study of cultural orientation gives us a model for understanding and predicting the results of intercultural encounters. A good training program addresses those subtle and sometimes invisible differences between cultures.

Boeing, the world's largest aerospace company, has over 300,000 employees in 28 different countries. It uses a mix of training methods, both with internal and external trainers to help its staff become more culturally aware. It arranges learning in a variety of methods including laid-back "lunch and learn" cultural talks and "passport series" training sessions that are more structured.

TIPS WHEN WORKING IN DIFFERENT CULTURES

Some examples of things that might differ between cultures that impact business might include:

Time and Punctuality — The first time we facilitated a workshop in the Middle East, we showed up at 8:00 a.m. to prepare for the workshop that was to start at 10:00 a.m. We waited at the door at 9:45. Nobody showed up until 11:00 a.m.. It is customary there to keep foreign businesspeople waiting.

Gestures — Some gestures that we use here in the U.S., like "thumbs-up" is considered crude throughout the Arab world. The left hand is also considered unclean in the Arab world. Gesturing or eating with the left hand is typically avoided.

Business Entertaining — In some cultures, it is rude to talk business when invited to someone's home or when dining out.

Negotiating — It is rude to say "no" in some cultures, so you have to be careful if making an agreement with someone. You may be hearing "yes" or "maybe" or "we will see" because someone is just trying to be polite.

There are so many nuances for each and every culture. They cannot all be covered or discussed in an article such as this, but the point is that training and being aware of cultural differences is very important in business as this world is getting smaller and smaller. It can help to have a cultural orientation for countries that your organization is dealing with in the international market. The process of communication is not static, but fluid. The success of your intercultural interactions depends upon you and the quality of your information. ***AMT***

ServiceElements is a Phoenix-based firm specializing in people-development and customer service training for aviation professionals.

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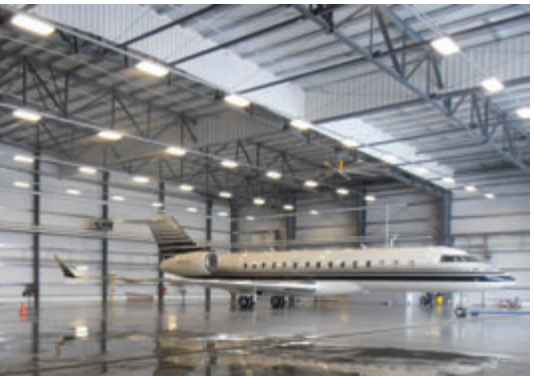

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THE ART OF THE DEAL....
INSURANCE RENEWAL NEGOTIATIONS

Maybe it is time to take a more proactive role in the renewal process. If your broker is not providing fast, accurate service, then it might be time to interview new brokers.

FOR THOSE THAT HAVE OWNED A MAINTENANCE shop, FBO, or aircraft for many years, the renewal process may seem "routine." You have answered the same questions every year and received the same rhetoric about getting your information updated in a timely fashion. You receive a quote and hear the same reasons from your broker why the insurance underwriters can't seem to improve your renewal pricing or policy. Many people go through this annual process assuming that their insurance broker has the knowledge and experience to negotiate with the underwriters and present their operation in the best possible way. The only thing left to do is accept their offer, right? Or can you do more?

Maybe it is time for you to take a more proactive role in the renewal process. If your broker is not providing fast and accurate service or regular pre-renewal visits with underwriters, then it might be time to interview new brokers. It doesn't matter if you are negotiating your aviation insurance for the first time or have had policies for years — the broker you select is the key to lower pricing, expanded/broader coverage, and peace of mind.

MEET WITH YOUR BROKER

There is no substitute for a face-to-face meeting with your broker. These in person meetings become even more crucial if you are an FBO or maintenance facility. This is critical to conveying the full and complete scope of your insurance risk, and discussing all aspects of your operations. Demand this basic service from your broker.

Once your broker has a full understanding of your operation, they can verify that you have the necessary coverage. The following are some examples of coverages on a General Liability policy that are not necessarily included and may not be discovered without a site review.

Incidental Premises Liability: An extension of General Premises Liability to provide coverage at locations incidental to the insured's operations. If you perform any work away from your primary location/airport premises, liability typically stops at the airport boundary. Most underwriters can offer this coverage, which extends the premises liability to locations you or your mechanics may travel to in order to perform repairs.

Fellow Employee Exclusion: An exclusion in most General Liability policies that eliminates "Insured" status for an employee if they cause injury to another employee. Some insurance companies offer broad form endorsements that do not contain the fellow employee exclusion. Some underwriters are willing to remove this exclusion from their standard policy form by endorsement. Many will not modify the "fellow employee" exclusion at all.

CONTRACTS REQUIRE REVIEW

Aviation is filled with contracts in every form. When visiting, I commonly request contracts from my clients as they are easily accessible.

Contracts are drafted for hangar facilities, maintenance, dry leases, pilot services, aircraft management, fuel supply, aircraft rental, etc. Each contract will likely include an insurance section and an indemnification section. These may affect your insurance coverage and may require a certificate of insurance. Each underwriting company should be provided an opportunity to review the contracts to help them fully understand the risk exposures. Most insurance policies require underwriter approval for such things as additional insureds and waivers of liability or subrogation, so a contract review is necessary and prudent.

OTHER FINE POINTS

As you can imagine, there are many more details to consider. It is important for you to advise your broker of any changes you had or anticipate in your operations. These points must be negotiated before you accept the underwriter's quote and prior to renewal.

Your broker can only help you if you help your broker. Be proactive. Volunteer information. The renewal application is simply a guide for deeper discussion and cannot be expected to cover every possible situation. Schedule a meeting with your broker and underwriter. That is your opportunity to ask them questions. This may result in more or broader coverage and reduced pricing. **AMT**

STEVE BRUSS is president of Wings Insurance, an independent aviation insurance broker headquartered in Minneapolis, MN. Steve has 22 years' experience in aviation insurance, and is also a licensed Commercial pilot and flight instructor. He can be reached at sbruss@wingsinsurance.com or by calling (952) 641-3140; www.wingsinsurance.aero.

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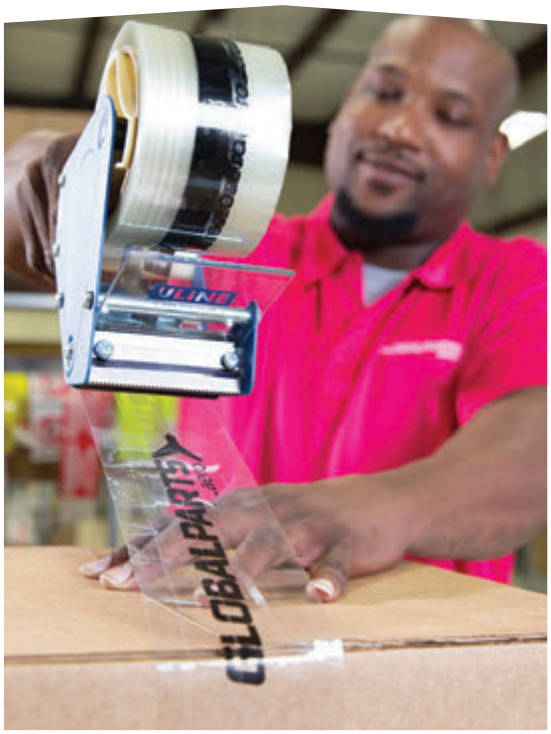

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BACK TO THE DRAWING BOARD— THE FAA'S REVISED RULEMAKING RULES

When an agency issues a regulation it should be clear, concise, and omit explanatory information that is properly reserved for guidance documents

THE AERONAUTICAL REPAIR STATION Association (ARSA) recently submitted comments on the FAA's proposed revisions to the general rulemaking procedures in 14 CFR part 11. ARSA's comments highlighted that regulatory text should be clear, concise and free of explanatory material that is more appropriately included in guidance. Departure from that principle — no matter how well intentioned — only creates future problems.

THE NPRM

On June 1, the FAA issued a Notice of Proposed Rulemaking (NPRM), 81 Fed. Reg. 34919. to consolidate procedures for all of the agency's rulemaking activities. Presently, commercial space transport regulations are promulgated using a different and sometimes overlapping process, 14 CFR part 404. Having two separate rulemaking avenues led to considerable confusion.

The NPRM attempts to alleviate that uncertainty by aligning the commercial space regulations with the general rulemaking procedures in part 11. Although space regulations usually do not concern the aviation maintenance industry, any change to the agency's general rulemaking procedures need to be reviewed. Unfortunately, as the FAA endeavors to bring clarity to part 11, the agency's proposal undermines that objective.

UNNECESSARY ENUMERATION

When an agency issues a regulation it should be clear, concise, and omit explanatory information that is properly reserved for guidance documents. In the rulemaking, the FAA proposes to revise §11.27 by listing the Commercial Space Transportation Advisory Committee (COMSTAC) as one of the advisory committees from which it can receive rulemaking recommendations. (The current rule only lists the Aviation Rulemaking Advisory Committee (ARAC) as an example of an advisory committee.) Enumerating COMSTAC, or any other specific committee, is unnecessary and by specifying only some of the potential rulemaking committees in the actual regulations, the agency runs the risk of misinterpretation and obsolescence, particularly because rulemaking committees dissolve and new ones are created.

To achieve the agency's ultimate objective of clarity, it would be forced to embark on a never-ending cycle to update rules with outdated information.

RELIABLE WEB ADDRESSES – AN IMPORTANT COMPLIANCE TOOL

Ensuring reliable information is provided in the regulations is essential to compliance. In this age, we consume most of our information through the internet. It is not uncommon to receive an error message when looking for information online, which makes the use of web addresses in regulatory text particularly problematic. If web addresses are to be included in a regulation, it is best to only use those that are static (i.e., least likely to change).

> By specifying only some of the potential rulemaking committees in the regulations, **the agency runs the risk of misinterpretation and obsolescence.**

The FAA proposes to update the web addresses in part 11, including at least one long, hard-to-remember link to a subpage buried somewhere in the agency's main website. Although the revision is well-intentioned, the address may, again, become defunct in the future.

If the FAA truly wants to bring clarity to the regulations, it must carefully contemplate the implications of what it includes. ARSA works to realize that end. **AMT**

KIMBERLY R. VILLIERS is an associate of OFM&K assisting with international aviation safety regulation compliance. Ms. Villiers has worked for an international air carrier and formerly practiced U.S. Disability Benefits Law.

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ATEC PUSHES VOICE OF MAINTENANCE SCHOOLS IN WASHINGTON, D.C.

The Aviation Technician Education Council board of directors, schools, and industry partners, met in Washington, D.C., last month for three days of Capitol Hill, FAA, and industry association meetings

HAROLD SUMMERS, HAI director of flight operations & technical services, briefs the ATEC board on what HAI members say about maintenance training and workforce development.

INSET: Fly-in attendees meet with Department of Labor and Department of Education officials.

OVER THE LAST FOUR YEARS THE AVIATION TECHNICIAN Education Council has made great strides in becoming the voice of Part 147 Aviation Maintenance Technician Schools. From our humble beginnings ATEC was focused on developing a platform for our membership that supported the work our universities and colleges do every day for our students and the industries that employ them. The bottom line is that ATEC is working to ensure that our institutional members have the regulatory environment to create advanced curriculums that are needed to meet the ever growing demands of our industry partners. For too long ATEC has been focused on just our institutional members when in fact it takes industry coming along side our member institutions to create the environment and the resources to produce world class technicians.

We all know that Part 147 is old, real old, and does not address the needs of the industry today. ATEC since 2007 has been leading a way forward to get this changed but industry involvement is critical. When the FAA initiated the Aviation Rule Making Advisory Committee in 2007 industry involvement was almost nonexistent. At the time I worked for Air Wisconsin Airlines and was involved with this process from beginning to end. Thanks to the efforts of our leader Raymond Thompson from Western Michigan this committee in its final report issued 11 recommendations. Since then ATEC has developed working groups tasked to address non-regulatory items on this list to include: allowing distance education, development of operational specifications, development of an FAA Inspector training course, and

CRYSTAL MAGUIRE, ATEC executive director, Ryan Goertzen, current ATEC president, and Amy Kienast, current ATEC vice president during the 2016 fall board of directors meeting.

rewrites of FAA guidance materials. All of which ATEC completed two years ago.

Finally after considerable effort by ATEC the FAA issued a Notice of Proposed Rulemaking (NPRM) that closed in February of this year. ATEC worked tirelessly with the FAA to develop and implement most of the recommendations of the 2007 ARAC as well as others to create an educational environment that is focused on advancing the curriculum as industry changes to ensure that our technicians have the skills they need to excel in today's aerospace sectors. We must continue this push and be relentless as an industry in our resolve.

INDUSTRY'S ROLE

Industry must and is taking a role to make change happen and nowhere was this more evident than in ATEC's annual Legislative Fly-In and board meeting in Washington, D.C., Sept. 8-10. Opened up for the first time to the entire membership, attendees scoured Capitol Hill to discuss FAA rule change and the growing concerning of a technician shortage.

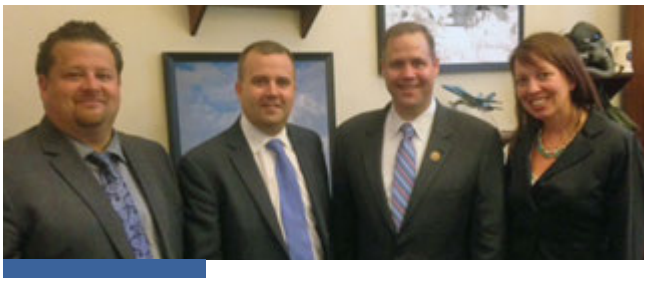
I praise Delta, United, and AAR for taking the lead with ATEC in meeting the workforce challenges that lie ahead in a three-pronged attack that allows ATEC member schools, industry members, and the FAA to work together in the development of a new regulation that makes sense and allows for

DEBBIE C. Wiggins, corporate director of aviation, Aviation Institute of Maintenance; Rep. Sam Graves (R-MO); and Andrew Smith, associate professor, Kansas State University – Salina.

educational change that is current with other industries. There is no bypassing the Airframe and Powerplant (A&P) with some other process or certification. Industry needs to focus on helping push through what ATEC has been proposing for years. The development of a Part 147 environment that is driven by the industry is the answer to the long-term needs for highly skilled technicians. Once the appendices of Part 147 are out of the rule, true change can happen that forces all schools to abide by the needs of the industry through a structured review process. Standards will be applied across the board and the need to focus on more avionics, or more electronics or inflight entertainment can be realized through this process.

Working together means that we finally get the FAA to finalize a long overdue rule, develop a way to keep the rule current and relative to the changes of the industry, and

CONGRESSMAN LAMAR Smith, (R-TX) and Donald Gregson, senior vice president of university operations, Hallmark University in San Antonio, TX.



DENNIS MANZO, president, Spartan College of Aeronautics & Technology - Los Angeles; Ryan Goertzen, chief aviation and academic officer, Spartan College of Aeronautics & Technology; Rep. Jim Bridenstine (R-OK); and Crystal Maguire, executive director, Aviation Technician Education Council.

drive constancy among all AMTS. The success of our meetings in Washington will culminate in another letter to Administrator Huerta by members of Congress urging the FAA to stay the course for a published rule in June of 2017. Our industry needs a regulation that works and is adaptable. We need an industry call for action around this topic to push this regulation over center. We need more industries to see the value of ATEC as an organization beyond Delta, United, and AAR. We need every airline, every MRO, every repair station pushing the AMTS legislative agenda every chance you get. We are doing our best at ATEC to work with members of Congress, working with the Department of Labor, Department of Education, and alphabet groups to drive this process in which I do see light at the end of the tunnel.

Having started my career as a pilot and then transitioned to the maintenance side of both a regional airline and MRO, I share in your frustration concerning Part 147 but ATEC has the solution. The development of dynamic competency based curriculum not tied to hours, allowing schools to maximize learning opportunities with relevant regulations, and developing pathway programs with the industry will lessen the gap that exists between what is currently taught and what the industry really needs. Please join ATEC to develop the pathway forward to creating at workforce that will propel our aerospace industry forward. **AMT**

For more information on ATEC visit www.atec-amt.org.

USTDA PARTNERS WITH CAAC ON AVIATION SUSTAINABILITY AND GENERAL AVIATION

The U.S. Trade and Development Agency signed two grants with the Civil Aviation Administration of China (CAAC). USTDA supports the bilateral aviation environmental initiative, the U.S.-China Aviation Green Route Initiative. This program will bring together public and private aviation stakeholders to identify ways to reduce emissions during aviation operations, thereby reducing greenhouse gases to combat climate change.

This project will explore how best to utilize business practices, services, and technologies that foster fuel efficiency and emissions reduction throughout all phases of flight operations. Through this grant, several U.S. companies will demonstrate the important role their emissions-reducing technologies can play during a flight's entire life cycle, from gate-to-gate.

In addition to supporting aviation emissions reduction in China, USTDA also agreed to support continued development of China's general and business aviation sectors. Funding for this activity builds on a long-term commitment by USTDA, CAAC, and the ACP to advance the opening of China's airspace for increased general and business aviation operations. The program will focus on aero-medical services, standards for general aviation airports, helicopter performance training, business model best practices, and next generation business jet performance training. This program will continue to assist the CAAC open the operation of low altitude airspace in China. The grant will also support the development of regulations to facilitate a robust general aviation sector in China.

PATTONAIR RENEWS UK CONTRACT WITH PALL

Pattonair, a global aerospace and defence supply chain provider, has signed a renewed contract for a further three years with Pall in the UK, representing the continuation of a 25-year relationship.

Pattonair serves the Redruth facility in Cornwall where Pall manufactures filtration solutions for civil and military applications, supplying directly to all the major airframe and engine OEMs. The new agreement covers a wide range of standard and non-standard hardware and other supply chain services and is managed by a Pattonair team on site.

LUFTHANSA TECHNIK STRENGTHENS ITS COMMITMENT TO ASIA

Lufthansa Technik has founded Lufthansa Technik Component Services Asia Pacific. And, a new location for component supply in Hong Kong has been established. The new warehouse offers a wide-spanning network for customer care in the Asian region along with the existing locations in Singapore and Narita.

In the new company, 30 employees will be responsible for local customer support in the Asia-Pacific region, in addition to ensuring they are optimally supplied with materials. The close proximity to Lufthansa Technik Shenzhen, the local maintenance organization of the Lufthansa Technik Group, is an advantage for the warehouse located at the Hong Kong Airport. Transport times and costs for material in need of repair can be minimized while maximizing the availability.

Lufthansa Technik will also use the latest technologies in order to increase turnaround on site even further. An example of this is the "gate box" (gate.control), an automatic material identification system for which a patent application has been filed. The new development from Lufthansa Technik Logistik Services will allow components to be allocated faster to suit demand while avoiding input errors.

SPAIRLINERS OPENS WAREHOUSE AND LOGISTICS CENTER IN SINGAPORE

Spairliners has opened a warehouse and logistics center for component supply in the Singapore Free Trade Zone, North of Changi Airport. Through an extensive stock of serviceable parts in Asia-Pacific, supported by a local repair network, Spairliners is able to increase the efficiency of its component supply and significantly shorten delivery times for its A380 customers, such as Qantas Airways and Malaysia Airlines.

State-of-the-art facilities, that operate 24/7, allow Spairliners to offer seamlessly integrated solutions for A380 and E-Jet customers. The new location covers a growing spectrum of critical Line Replaceable Units (LRU) for Airbus A380 aircraft and in order to support more customers, is now ready to expand to Embraer E-Jet aircraft.

LUFTHANSA TECHNIK AND MTU AERO ENGINES EXPLORING JOINT VENTURE

Lufthansa Technik and MTU Aero Engines are looking into options to jointly provide maintenance, repair, and overhaul (MRO) services for the PW1000G family of geared turbofan engines. The two companies have signed a memorandum of understanding to explore the possibility of establishing an MRO joint venture at a globally competitive location. Decisions will be made by the end of the year.

The joint venture could handle a substantial amount of GTF shop visits already in the first few years of business. The objective of setting up a joint facility is to generate opportunities for synergy and scale for both companies.

IAG ENGINE CENTER ACQUIRES ALITALIA MAINTENANCE SYSTEMS ENGINE REPAIR BUSINESS

IAG Engine Center Europe, a division of International Aerospace Group (IAG), has completed the acquisition of the engine and component repair business of Alitalia Maintenance Systems (AMS). IAG plans to operate an engine maintenance and repair facility in Rome adding engine repair and overhaul capability for CFM56-5B and 7B, as well as APU overhaul and repair capability to its existing overhaul and repair capabilities for CF6-80, CF6-50, and JT9 engines. Between its U.S. and European

repair shops, IAG can reach most of the world's fleet providing strategic and operational support and services to airlines and lessors.

ATS ACQUIRES TEXAS PNEUMATICS SYSTEMS INC.

Aviation Technical Services (ATS) has acquired Texas Pneumatics Systems (TPS) Inc., which provides repair and overhaul services for commercial airlines predominantly for pneumatic and fuel-related components and systems. Located near Fort Worth, TX, TPS has been in business for 20 years and employs a team of about 100.

ROLLS-ROYCE APPOINTS NEW CFO

Stephen Daintith has been appointed Rolls-Royce chief financial officer and as an executive director of Rolls-Royce Holdings plc. Daintith will take up his new role in 2017, succeeding David Smith who will leave Rolls-Royce after three years to pursue other business interests. Smith will remain in the post into next year to ensure an effective transition.

BOMBARDIER REORGANIZES LEADERSHIP TEAM

Jean-Christophe Gallagher, formerly vice president, strategy, marketing and innovation, has been named vice president and

general manager, customer experience. He will report to David Coleal, president, Bombardier Business Aircraft.

Andy Nureddin has been appointed vice president, customer support and training, reporting to Gallagher. He will be responsible for all aspects of customer support, including warranty administration, worldwide field support and customer care, technical publications and technical services, as well as the Business Aircraft training centres.

NATA NAMES MARTIN HILLER PRESIDENT

At its fall board meeting, the chairman of the National Air Transportation Association (NATA) board of directors, Andrew Priester (president and CEO, Priester Aviation, Wheeling, IL), announced that Martin Hiller (owner and partner, Marathon Jet Center, Marathon, FL) will continue to serve as president of NATA. He was named acting president upon the departure of then President Tom Hendricks. Hiller has served over five years as an NATA board member. The board also promoted NATA senior vice presidents, William Deere and Timothy Obitts. Deere will serve as executive vice president of government and external affairs. Obitts will serve as executive vice president of operations and business, and will continue to serve as general counsel.

NEUPER NAMED PRESIDENT/CEO OF MTU MAINTENANCE CANADA

In September, Helmut Neuper took over the role of president and CEO of MTU Maintenance Canada. He joins MTU in Canada after nearly three years as chief operating officer of Airfoil Services Sdn. Bhd., a joint venture between MTU Maintenance and Lufthansa Technik. Neuper follows interim CEO Matthias Voss.

Neuper holds a degree in aeronautical engineering as well as an Executive MBA and has worked in various positions within MTU and related companies throughout his career. He has gained extensive knowledge of the company's location in Vancouver, Canada, most recently during his time as director of accessory business from 2007-2013.

ELLIOTT AVIATION RECEIVES 100% AUDIT SCORE

Elliott Aviation received a 100 percent score on its recent Embraer factory audit. The company had previously received a 99 percent score on its biannual audit in 2014.

The factory audit consists of infrastructure, organization, security, certification, training, tooling, planning, maintenance tracking, and customer care. Elliott's Phenom team has successfully completed several Phenom 72-month inspections and was one of the first facilities to do an aftermarket paint job on a Phenom 300.

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Terri Petitt, Director, Audience Development — September 15, 2016

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TOOLS & EQUIPMENT

WE'RE LOOKING FOR A FEW (THOUSAND) GOOD TECHNICIANS

Where can we look to find the next generation of aircraft maintenance technicians who will make sure tomorrow's aircraft are safe to fly? It's a question we're constantly thinking about

PETE BUNCE is president and CEO of the General Aviation Manufacturers Association (GAMA), which represents more than 85 of the world's leading manufacturers of general aviation airplanes and rotorcraft, engines, avionics, components, and related services. GAMA's members also operate repair stations, FBOs, pilot and maintenance training facilities and manage fleets of aircraft. For more info: www.gama.aero.

WHEN BOEING RELEASED ITS 2016 PILOT AND Technician Outlook recently, the numbers in the report were staggering. Between 2016 and 2035, the company expects the global commercial aviation industry to require approximately 679,000 new commercial airline maintenance technicians — or 11.3 percent more than the number Boeing estimated in its 2015 report.

The good news for those seeking a profession in aerospace is that Boeing believes our industry will need more technicians because more aircraft will be flying. The need will be greatest in the Asia-Pacific region (268,000 technicians), followed by North America (127,000), Europe (118,000), the Middle East (66,000), Latin America (50,000), Russia/Confederation of Independent States (26,000), and Africa (24,000). But just where will the annual production of 35,000 new technicians come from?

As *AMT* magazine readers know, general aviation is often the training ground for those who work in the commercial aviation sector. So where can we look to find the next generation of aircraft maintenance technicians who will make sure tomorrow's aircraft are safe to fly? It's a question we're constantly thinking about as we look to increase the number of professionals in all aspects of general aviation .

GETTING STUDENTS EXCITED

Getting students excited about aviation as a career while they're young is critical. My own early experiences — riding in my aunt's GA airplane as a toddler — cemented a lifelong passion that led me to the U.S. Air Force and then to GAMA. That's why general aviation organizations are hosting programs to encourage high school students to consider aviation — including maintenance — as a career. In my last column, I mentioned the GAMA Aviation Design Challenge that teaches the basics of aerodynamic engineering, with a prize for the best work being a two-week build of an actual aircraft. If you know of a U.S. high school that might be interested, please encourage them to apply.

For students interested in an aviation career without the hefty price tag of a four-year degree, community colleges offer an excellent path to gain the skills needed for maintenance and other aircraft jobs. The National Center for Aviation Training at the Wichita Area Technical College in Kansas, for example, is continuing the work of the National Aviation Consortium by offering manufacturers a pipeline of students with the knowledge needed to successfully maintain aircraft. And, of course, many universities offer excellent aviation programs that prepare students well for a host of aviation jobs.

NEW TECHNOLOGIES

Publicizing the development of exciting new technologies is another way to capture young people's attention. I remember vividly the race to the moon and watching Neil Armstrong jump off the ladder of the lunar module. With the introduction of new electric and hybrid propulsion aircraft, as well as the thousands of unmanned aerial vehicles entering the market, a new generation is experiencing the excitement of flight — which will hopefully inspire them to learn more about the design engineering behind aircraft development and the maintenance and repair work required to keep them flying.

CAREER OPPORTUNITIES

Aviation maintenance also offers tremendous opportunities for those looking for a new career, whether it's after military service, a transition from a manufacturing job in another sector, or an unrelated profession. The median age of our current aviation workforce is increasing at the same time it is poised for growth, as the Boeing numbers show. This is no small challenge in a global job market that is constantly evolving.

As we seek to recapitalize and grow our technician workforce in the coming years, I have no doubt that the talent exists — but addressing it will take a very focused effort. Not only do we need to expose, excite, and entice young people to our industry, but we have to educate parents about the great career opportunities for their children. Figuring out how to do that will require all of our efforts, but the payoff to meet the worldwide demand for aviation and keep our aircraft flying safely will be well worth it. **AMT**

"When choosing a facility for major MRO work, I always look for recommendations from fellow members of the aviation community. Prior to working with Elliott Aviation, I heard great things about their quality and commitment to stand behind their work. Our first major project involved a total overhaul of our King Air for a Phase 1 through 4, Garmin G1000, Blackhawk engines and a complete customized paint and interior refurbishment. That project being completed on budget and ahead of schedule made the decision easy to bring our Falcon to Elliott for complete paint and interior. Throughout the process, the paint and interior design was incredible, the project management was exceptional and the final product was flawless. When we work with Elliott, we are not just a customer we feel like we are part of their family."

Brendan Goss
Chief Pilot
Ballengee Aviation - Dallas, TX

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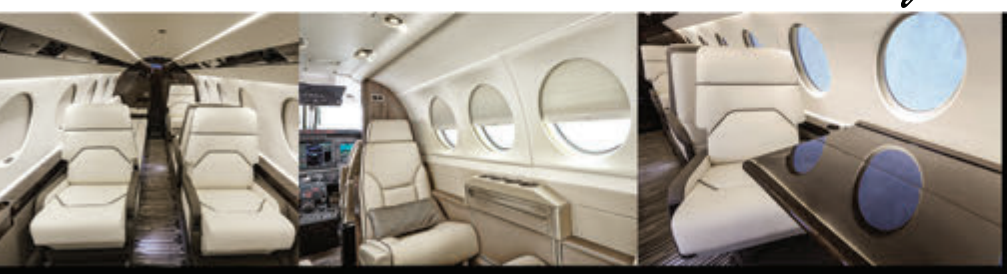

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