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AMT

Aircraft Maintenance Technology

Written by aircraft maintenance professionals for the professional maintenance team

Official publication for AMTSociety

October 2012

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ASSEMBLY FACILITY

AMT gets an inside look at Embraer's state-of-the-art campus in Melbourne, FL

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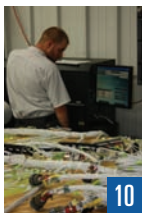

Check out AMT iPad

Departments

iPad Features:

This AMT iPad issue combines key articles from both our September and October print issues of AMT into one iPad app issue. Moving forward we plan to continue with the combined format for our iPad apps. As you scroll through, you'll find many more articles from September and October so sit back and enjoy the app.

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Expectation Bias

Ron Donner,
Editorial Director
Aviation

Ronald (Ron) Donner has spent his entire life devoted to aviation and he holds FAA certificates as an A&P/IA, and a Commercial Pilot with Single and Multi Engine Land, Instrument Airplane and Glider ratings.

A recent pilot safety tip published by the FAA Safety Team talks about e*xpectation bias*; the suggestion that we sometimes hear what we expect to hear. The example used in the safety tip to explain the concept of expectation bias went like this:

A pilot calls the control tower and reports ready for departure on Runway 10. The controller clears the pilot for takeoff on Runway 17. The pilot reads back his clearance for takeoff on Runway 10 – and then stops on the runway when he spots an aircraft inbound in an opposite direction for his or her runway. In this case the pilot was captured by the expectation of what he or she was expecting to hear. The European Air Traffic Control (ATC) unit Eurocontrol defines ATC expectation bias as "Having a strong belief or mindset toward a particular outcome." Hearing what we *expect* to hear is frequently listed as a causal factor for pilot deviations that occur both on the ground and in the air

After reading this safety tip I speculated on how this same situation would apply to aircraft maintenance, especially in the rapid-paced noisy environment of airport line maintenance and ramp operations. How could an *expectation bias* catch the aircraft maintenance professional in a situation where he or she expected to hear a certain response, direction, or instruction but what was said was not the case. One possible scenario that comes to mind would be a technician who was asked by a coworker, let's say an inspector or supervisor, a simple question over a two-way communication device like, "We are ready to go, did you close that access panel?" The expected response or perhaps the hoped response from the coworker may be something like "Yes I did it's all closed up." But what if the response was not the one expected and even masked by a partially garbled transmission or a noisy environment? What if the response was something like, "Yes…(garbled sounds) I'll … (more garbled sounds) … soon." Could the response have been, "Yes I'll do it soon," and not the expected response the task had been completed, the aircraft ready to be returned to service, and the technician will be back in the ready-room soon?

When issued instructions or asked questions, listen intently and repeat them to yourself and back to your coworker.

Rapid communication is part of our daily lives and workplace distractions and multi-tasking in a maintenance environment can compound the already difficult challenges of effective communications. Similar to the pilot communication with ATC, when issued instructions or asked questions, listen intently and repeat them to yourself and back to your coworker.

Ask yourself, did this quick verbal instruction make sense; did I hear this correctly? Much has been written and taught on effective communications. Attend any training session relating to working with others, supervising and managing people, and listening and understanding is generally on the top of the list of important factors. If in doubt ask for clarification and use the popular pilot communication phrase, "Say again please."

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The CF34 Turns 20

A model for reliability with 10 versions to date

By Charles Chandler

Charles Chandler began his aviation career as a junior mechanic for American Airlines and retired after 27 years of service.

This year marks the 20th anniversary for GE Aviation's CF34 family of engines. The military version TF34 which powers the U.S. Air Force A-10 and U.S. Navy S-3A, was a key factor in developing engines for the regional jet market.

There have been 10 versions of the CF34 to date, beginning with the CF34-1 that was used on Bombardier CL-601-1A through the CF34-10E used on the Embraer E-195. The first commercial -3 model was installed on the CRJ 100 and CRJ 200 aircraft in 1992. This engine family has been on the GE Aviation's best seller list for a long time.

On May 25, 2010, GE announced it had delivered the 5,000th CF34 engine. The CF34 engine has evolved over the decades with design changes and modifications to increase thrust, reduce parts, and strengthen the core engine resulting in improved performance and lower maintenance costs. The durability and reliability of these engines is incredible — with more than 80 million flight-hours and 65 million cycles completed, the dispatch reliably remains at 99.95 percent.

It is interesting to compare some of the specifications of the various models. The CF34-3 is 103 inches long, has a diameter of 49 inches, and a dry weight around 1,650 pounds. The core engine has a fan and 20 combined compressor and turbine stages. It has a power-to-weight ratio of 5.6:1 and thrust at sea level is 9,200 pound-feet. This engine would typically power aircraft like the Bombardier CL-601. The latest model, CF34-10, is only 90 inches long, has a larger diameter of 57 inches, and a dry weight of

CF34 variant in the final assembly process.

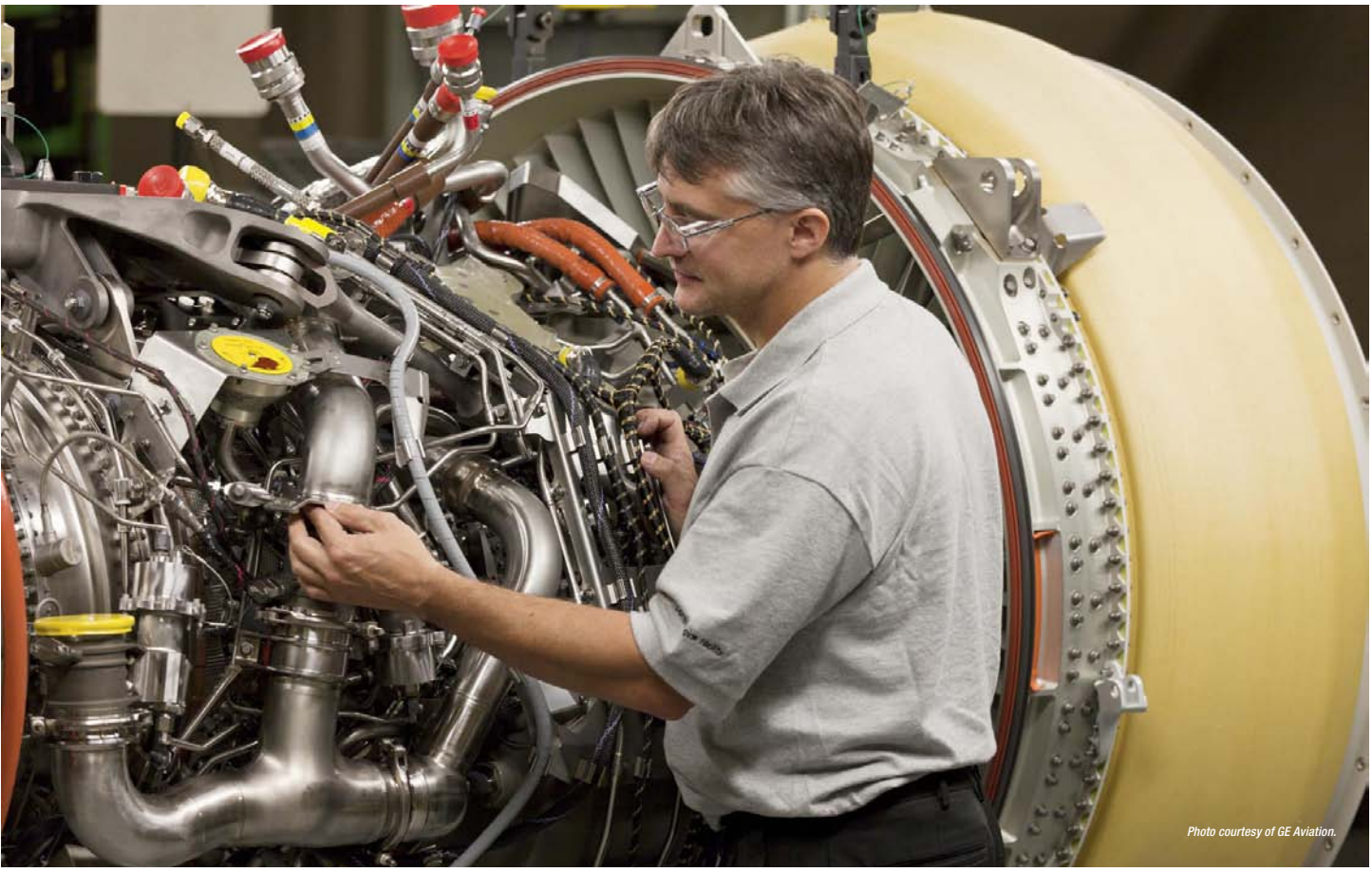


Photo courtesy of GE Aviation.

3,700 pounds. The core engine has a fan with three additional "booster stages" and only 14 total stages for the compressor and turbine.

The new CF34-10E has a higher thrust rating of 20,000 pound-feet, and lower fuel burn and maintenance cost. This radical increase in thrust was produced by a single-stage high-pressure turbine, advanced wide chord fan blades, and advanced 3-D aero compressor and turbine airfoils. The CF34-10E engine powers the Embraer E190 and 195, and the new Embraer Lineage 1000 business jet that entered service in mid-2009.

Outlook for the CF34 family

The utility of the smaller 50-70 seat regional jet in some North American markets is being questioned. According to Judd Tressler, GE Aviation's director for CF34-3 Commercial Engines, "There will be fewer numbers of those aircraft in North America but they won't all go away, just move to other markets with demand for that seat capacity."

Tressler was asked if the large numbers of CF34-3 engines that have been in service for the last 10 years are being pulled and sent to the shop for overhauls. "There was a large peak in aircraft production about eight years ago. Those engines reached their first shop visit over the last few years and there was a wave of shop visits.

"The GE overhaul facilities are seeing the back side of that peak now so they are working with operators to develop different services like shop visit optimization programs, fixed cost by the hour, and other creative ways to reduce maintenance cost."

MROs and GE branded service

With more than 5,600 CF34 engines in service, GE must have a global network of service providers operating on a 7 by 24 schedule, providing spare leasing, major overhaul of engines and components, and a ready supply of parts. Major engine overhaul is completed at GE's Strother facility near Arkansas City, KS, but GE has a network of service providers located around the globe.

Tom Hoferer, GE Aviation's director for CF34 Engine Services, gives some insight to GE's vetting process. "When selecting an MRO partner, we look for one that has made the necessary capital

Photo courtesy of GE Aviation.

The GE CF34 family of engines has provided power to both business aircraft and regional airliners for 20 years.

investment to be in business for the long term. The location of their operations is very important because we must ensure we have regional service coverage for our customers. They must have FAA or country-equivalent certifications and demonstrate an allegiance to the OEM so the MRO is perceived as an extension of GE services.

"We are looking to add one service facility in Brazil and one in China sometime over the next five years. However, we are being very aggressive in the business jet market. We have 21 authorized service centers in the U.S. and are looking to grow our global centers with another 17. We will be providing mostly level 1 line maintenance at these centers. Other services are provided in a GE branded service facility or GE-authorized shop."

MTU Maintenance Berlin-Brandenburg

One of those service providers for the repair and overhaul of the CF34 is the German company MTU Maintenance Berlin-Brandenburg, a wholly owned affiliate of MTU Aero Engines, Germany's leading engine manufacturer and a public listed company.

GE Aviation and MTU have been cooperating closely both in the manufacturing of several engine types like the CF6, the GP7000, and the GENx and in the after sales market. This decision was based on MTU's ability to offer especially to European CF34 customer's facilities, technology and services that meet GE's quality and customer service standards.

MTU Maintenance Berlin-Brandenburg was the first independent MRO provider that could service all models of the CF34 family of engines. MTU offers a vast array of services, among which are modifications, retrofitting, repair, and overhaul, on-wing services as well as engine condition monitoring, spare engine leasing, and AOG support.

MTU Maintenance Berlin-Brandenburg has been a GE-branded service provider since 2001 and has extended its agreement until 2022. The company also has signed a component repair development agreement with GE. There are about 650 employees in the facilities located south of Berlin.

Typically, their technicians complete a three-year dual apprentice program and are certified by EASA. According to Nils Fenske, director of sales and

marketing CF34, this intensive training has a big impact on the quality, capacity, and turn-around times. Production figures given by Fenske were impressive.

So far, they have overhauled up to 130 CF 34 engines per year with a breakdown of 80 -3s, 25 -8s, and 25 -10s. Depending on the workload, the technicians can overhaul the -3 in about 45 to 55 days and the -8 in about 55 to 65 days. The time for overhaul on the -10 varies due to the fact that the upgrades in the scope of work require more collaboration and communication with GE staff.

"We are looking to add one service facility in Brazil and one in China sometime over the next five years. We have 21 authorized service centers in the U.S. and are looking to grow our global centers with another 17."

— Tom Hoferer, Engine Services Director, GE Aviation

I asked Fenske to give me his opinion as to why the CF34 family of engines is so reliable and durable. He suggests that it is because the engine has a very robust compressor, and hot section engines are usually pulled because of the life limits of parts and not because of wear and damage. When questioned about damage, he says that "FOD damage is usually not a significant issue and can be fixed with top case repairs rather than pulling the engine." In fact the MTU motto is "repair beats replacement."

It appears that the CF34 family has a bright future and long life ahead. The CF34-10E model has been performing well and developing an excellent record with 1,100 in service and 7 million hours flown. So what is next for the CF34 family? The GE interview members say, "We will continue improving the CF34-10 engines," however, like all things, change in aviation is inevitable, expected and necessary.

As Will Rogers, my favorite philosopher said, "You may be on the right track but you will get run over if you just sit there!" GE Aviation seems to be on the right track and not just sitting on its legacy because there is a new player in town.

Mary Hussey, GE Aviation's marketing manager for Small Commercial Engines, says the GE Passport "Next Generation" engine will soon be powering the Bombardier Global 7000 and 8000, and GE has a technology development program, called the NG34, to mature technology for the next-generation CF34 engine. What is next for the CF34 product line? Maybe time and customers will tell. Whatever occurs, our aviation techs will have plenty of interesting engine work to perform. **AMT**

The CF34 inner workings being inspected in the MTU Maintenance Berlin-Brandenburg facility in Germany.

G1000 King Air Retrofit

Avionics upgrades breathe new life into well-aged airframes

By Ronald Donner

Ron Donner has held both technical and management roles in general aviation and during his 27 years with Northwest Airlines. He holds FAA certificates as an A&P/IA and a commercial pilot.

Most tried and true airplanes have any number of aftermarket modifications and upgrades available and the Beechcraft King Air is one of them. The first airplane in its class, the King Air line of aircraft has been in continuous production since the early 1960s beginning with the Model 90 and 100 series.

Later the larger siblings came along, the 200 and 300 series, which were originally marketed as the Super King Air family, and this line has been in continuous production since 1974. In 1996 the distinction "Super" was dropped by Beechcraft, although many are still known to use the name Super to differentiate them from the smaller airframes.

Some of the typical upgrades and modifications have been engine and propeller upgrades, cargo conversions with a larger rear door, wing spar modifications, larger baggage compartment in the nose section and engine nacelle compartments, and many more including of course avionics upgrades.

The Garmin G1000 Suite

When it comes to the flight deck one can argue a strong case that perhaps the ultimate King Air upgrade so far may be the Garmin G1000 retrofit. The G1000 suite integrates all primary flight, navigation, weather, terrain, traffic, radio frequency, and engine and fuel data readouts on large-format, high-definition liquid crystal displays (LCD).

The cockpit layout features a 15-inch multi-function display (MFD) in the center, and 10.4-inch primary flight displays (PFDs) at the pilot and copilot positions. The G1000 system for the King Air also includes the GFC 700, a three-axis, fully digital, dual-channel, fail passive Automatic Flight Control System (AFCS) capable of using all data available to G1000.

Because the G1000 integrates so many components into one system, depending on the model, most airplanes can see a weight savings of at least 200 pounds, 65 of which relates to the wiring harness alone.

Another offering is the Electronic Stability and Protection (ESP), an option for new King Air 200, 300, and 350 series retrofits. The ESP is designed to provide another layer of protection when the pilot is hand flying the aircraft by applying a gentle corrective force to the yoke when it detects excessive

King Air 350 instrument panel before the retrofit.

King Air 350 instrument panel after the retrofit.

Avionics technician Jon Young demonstrates some of the functions of the Garmin G1000 on Elliott's King Air simulator.

pitch and roll. And there's more. Because the G1000 integrates so many components into one system, depending on the model, most airplanes can see a weight savings of at least 200 pounds, 65 of which relates to the wiring harness alone. Garmin holds the Supplemental Type Certificate (STC) for the G1000 upgrade to the King Air C90B, 200, B200, 300, and 350 models.

The Elliott Aviation install

To understand more of the installation, I visited Elliott Aviation in Moline, IL. Mark Wilken, director of avionics sales, describes the program. "We began the program in 2009 and today we accomplish two to three G1000 King Air upgrades per month and are currently celebrating accomplishment of 75 aircraft."

He goes on to say that in order to understand why this program has been such a success you need to go back a couple decades.

Wilken says, "As we all know technology has driven dramatic changes in avionics. It seems like not long ago we had round-dial mechanical instruments. Then in the early 1980s the cathode ray tube (CRT) became a standard in cockpits and continued into

the last decade. But what happens when your CRT eventually fails? Replacement costs are high. Some operators are known to have spent upwards of $20,000 per year for avionics maintenance and component replacement costs. At what point do owners and operators say enough." He goes on to describe how the consumer electronics industry transitioned to LCDs and the CRT really became obsolete.

"In aviation the similar took place and obsolescence of certain electrical components drives upgrades. I believe this is when Garmin stepped into the scene," Wilken says.

Jon Young, avionics lead technician, gave me a demonstration on the Elliott King Air G1000 simulator. Although I am a pilot, I'm not current on modern avionics systems and rapidly became overwhelmed by all the available functions. It was clear the system has the capability to do most anything. Young, who holds an Avionics Repairman Certificate and Private Pilot Certificate, demonstrates the G1000 capabilities to all pilots considering or upgrading King Airs. Young flies with the flight crews after the install to demonstrate and educate pilots on the system. Yes, that's correct, the technician teaches the pilot.

A well-choreographed dance

Jeff Dean, one of the G1000 service team leads and holder of an A&P/IA, says it really begins when an airplane arrives before it ever comes into the hangar with a very comprehensive incoming acceptance check. Dean explains how they accomplish a complete check of all the systems in the airplane, not just the avionics. The induction checks include power runs to check all of the engine instruments and indications, a pitot-static system check, all the way to verifying the position and that cabin lights work correctly.

Dean says, "When the aircraft comes into the hangar, we know everything about it. We do not want an airplane going into final check outs with any problem that we are not aware of." The aircraft is defueled for weight and balance purposes done later in the program and it's jacked and leveled. Areas of the aircraft tail section are checked for hidden magnetism that later may affect new sensors located there.

All the technicians involved go through two days of Garmin G1000 maintenance training which provides an overview of the system and typical fault troubleshooting practices. The STC and installation instructions have very specific requirements for even the little things like

Elliott technicians, left to right, Jeff Dean, Paul Schmidt, and David Sachleben discuss STC installation instructions.

exact wire termination methods or wire shield lengths.

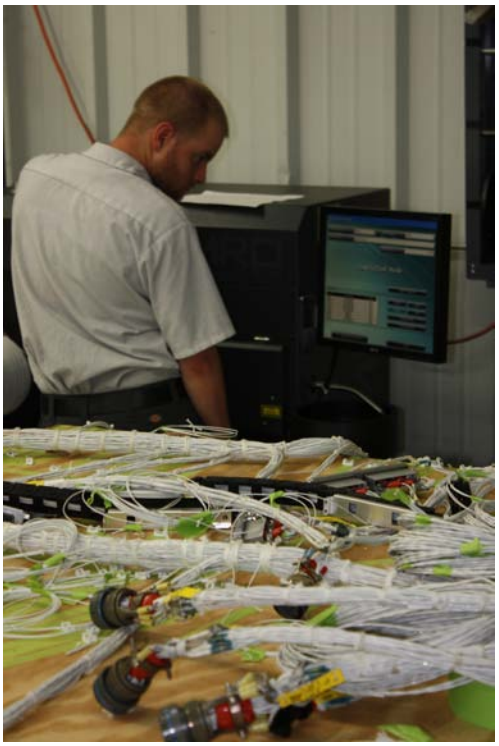
Elliott uses dedicated teams of technicians specializing in fabrication and installation such as the interior team, structural team, wiring harness fabrication, harness installation, and system check-out and flight test. Each team and the technicians have goals and sub-goals and the install teams have even developed a friendly competition with each other.

Elliott Aviation fabricates as much of the individual piece-parts as possible in-house and feels fabricating in-house provides much better control of the quality and the overall aircraft downtime.

All the technicians involved go through two days of Garmin G1000 maintenance training which provides an overview of the system and typical fault troubleshooting practices. The STC and installation instructions have very specific requirements for even the little things . . .

Dean's team supports the systems maintenance portion and he walked me through a few portions of the program. He described the G1000 as having numerous sensors located throughout the aircraft for any number of systems like the engines, landing gear and flap position indication, flight controls, autopilot systems, and more. All of the autopilot servos are removed and replaced.

A new King Air instrument panel is prepared for installation.



Elliott fabricates all wiring harnesses in-house for its King Air G1000 retrofit program.

It's not just an avionics package in the traditional sense of installing new communication and navigation radios. Dean says, "Because the G1000 is totally integrated into the aircraft, all of the analog transmitters are removed and new data transmitters installed. Synchronizing the engine displays after installation can be a challenge."

Dean explains the digital displays have a much greater accuracy of readings than the traditional analog instrumentation and transmitter units. On the analog gauges the pilot may not have been concerned with or even noticed a slight difference between say the left and right needles for a 3-psi difference in oil pressure, a 5-rpm difference between the left and right propellers, or a 10-degree difference in the turbine inlet temperature between the left and right engines. These slight differences are now clearly recognized on the digital display even though the difference may have always been there. "Some pilots now become very particular with this and at times trying to make these types of exact adjustments is like opening Pandora's Box; one adjustment may affect several other data points," Dean says.

Engine analog transmitters are replaced with new data transmitters to support the G1000.

When I asked Wilken what has made this program a success for Elliott he mentions a couple items. "First the King Air is a great platform for the G1000 upgrade. The airframe ages very well and lends itself toward continual upgrades so an upgrade to a new technology flight deck works well." Next, he says, "It's our recipe" — but stops short of describing too many of the details of what goes into that recipe. He sums up by saying, "It's a well-managed program and a well-choreographed dance by the technicians."

Dean closes by saying, "To wow the customer is the greatest challenge and the greatest reward. I love doing this; it's a really fun job!" **AMT**

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Process-Driven Checklists for GA

Checklists are an effective production and control tool

By Vern Berry

Vern Berry began his aviation career as an A&P mechanic in 1979. His experience within the aviation industry includes key management roles in quality and safety for both MRO and air carrier operations. He currently resides in upper state New York where he writes and manages a consultant firm at www.blowntireaviation.com.

In spite of all the advancements in managing aircraft maintenance information and behavior, we all benefit when the playbook is simplified. Safety begins with how we see things on the hangar floor. It's easier when the tools we use help us exercise more control over our work environment. Process-driven actions on the hangar floor of general aviation facilities do not have to be cumbersome or complex.

Let's begin with a discussion of a tool everyone knows: the checklist. Do you use one for annual inspections? When the checklist was written what thought was given to what it should contain or what use could be made of it? What was its purpose when it was developed and how is it used?

The checklist is the basic production and control tool. It starts as a "to-do" list. In fact, Appendix D of 14 CFR 43 contains the FAA's "to-do" list that defines the basic annual and 100-hour inspections.

We can incorporate these tasks into a checklist format. Looking at Figure 1 we see that this checklist is not so different from a grocery list. In fact we could just roll along with a check mark in each row as we accomplish work on the aircraft.

Figure 1

Cabin and Cockpit Group:

Generally — for uncleanliness and loose equipment that might foul the controls.

Seats and safety belts — for poor condition and apparent defects.

Windows and windshields — for deterioration and breakage.

Instruments — for poor condition, mounting, marking, and (where practicable) improper operation.

Figure 2

Item No.	Task Description	Mechanic *(Initials or Signature)*
1.	**Airframe – General**	
1.1	*Fabric and skin — for deterioration, distortion, other evidence of failure, and defective or insecure attachment of fittings.*	
1.2	*Systems and components — for improper installation, apparent defects, and unsatisfactory operation.*	
1.3	*Envelope, gas bags, ballast tanks, and related parts — for poor condition.*	
2.	**Cabin and Cockpit Group:**	
2.1	*Generally — for uncleanliness and loose equipment that might foul the controls.*	
2.2	*Seats and safety belts — for poor condition and apparent defects.*	
2.3	*Windows and windshields — for deterioration and breakage.*	

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Computers have managed to morph the checklist into a powerful device that can be so much more than a "to-do" list. By adding a heading and additional columns (Figure 2) we have a better record of our performance and the performance of others. We can track progress of personnel to whom we assign work as well as create a record of current status to remind ourselves of where we are in the inspection process. (That's good if we are working by ourselves.) From a project management perspective we have an idea of where we are, who has done what and what's left.

Checklists are adaptable and can serve many purposes:

Production tool:

It can be the basis for establishing an estimate of the work – write man-hours or job time in the mechanic block as a work sheet. Add it all up and see if you have enough hours in the day to do the work. When you are juggling multiple customers and deliveries, knowledge like that is useful. Being stretched too thin creates the temptation to cut corners.

Inspection diary/turnover record:

It can be a task reminder of where we are and what is going with the aircraft. A work turnover is a diary of the day's activities. Entries are safety related as well as information of concerning incomplete work.

Some examples include: Rig pin or lock pin installations, circuit breakers status – safety prohibitions to actuation of a system, safety issues related to explosive actuated systems such as parachute/rocket combinations, wet paint, and operational checks requirements.

Yes, you can make a turnover if you are the only one on the job or if there is only one shift. Having a tool that reminds us of what we already know and keeps us from making embarrassing omissions.

It's important that personnel record the last step accomplished in an interrupted procedure to assure that work doesn't begin at the wrong place.

A section on the reverse side of a page can be designed to record key things that you may want to note as the inspection progresses. See Figure 3.

Record of material history and component control

Material issues can be recorded in the checklist to show component changes. Component removal and installations are important items to include with any work order. A separate section of the checklist format can be created for attachment or printed on the reverse side of the checklist. Once completed, they create a history of parts information related to the work order. A diary of component histories comes in handy for future work when the aircraft returns for repeat business. See Figure 4.

Safety checks

In general aviation maintenance operations the mechanic simply signs for his work with his A&P in the log or on a work order format. Checklists can and are often used with no inspection column – in a small shop with a few mechanics a person may do much of the work alone. A buy-back process such as a safety check has to be developed from the floor in cooperation with the folks who will be subject to the process. Mechanics may resent having their work "judged" for correctness.

From a human factors point

Figure 3

Item	Work Card or Inspection item ref	Actions	Action Acknowledged/ Closed/ Name
1			
2			
3			

Figure 4

Item	Work Card or Inspection item ref	Part Order Info - parts source & shipping	Part Description	Component Removed	Component Installed	Parts Status
				P/N off	*P/N on*	
				S/N off	*S/N on*	

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Figure 5

Item No.	Task Description	Mechanic *(Initials or Signature)*	Safety Check
1.	**Propeller Group: Inspect**		
1.1	*Propeller assembly — for cracks, nicks, binds, and oil leakage.*		
1.2	*Bolts — for improper torqueing and lack of safetying.*		
1.21	Safety Check item — Bolts torque check – verify torque wrench setting and the torque results. Verify that safeties are correct.		
1.3	Anti-icing devices — for improper operations and obvious defects.		

of view, the act of inspecting another's work needs to come with mutual acknowledgment by both parties that errors found are not a personal reflection of a mechanic's technical competency. In fact, there is a tendency for the most egregious errors to be caused by the most experienced technicians since they are often the ones who are called on to perform the most challenging tasks. Though they are rare, the outcome of a slip or misjudgment on their part may result in more severe consequences.

If a little effort is applied, key elements of an inspection process similar to the required inspection processes in air carriers can be designed into any checklist in nearly any operation. By definition, a required inspection item (RII) is a maintenance item that, if improperly done, creates an immediate hazard to the flight. In this discussion I am going to refer to "RII-like" items as safety check items.

These items can be found on any aircraft of any type. The point here is to assure that there are no quality escapes in the work. It may seem that we are calling artillery on ourselves, but asking for a second set of eyes as a matter of practice will capture errors that, while embarrassing if found, are dangerous if not. Use of an "RII-like" process may never reveal an error. But it only has to do it once to make its use worthwhile.

In review of the aircraft systems and the inspection checklist, you can make some decisions on what to designate as a safety check item on the RII definition. For example, in performing a propeller installation, a key part of the installation would be the mounting bolt torques and their subsequent "safetying" with the right wire. The checklist could be formatted to show a verification of the torque and safeties by a second person. One mechanic does the work and another is tasked with witnessing the torque. Prior arrangement for this kind of activity is necessary. Also this is a safety check and not a return to service action. See Figure 5.

A search on the internet reveals that there are lots of checklists out there for the use of the general aviation mechanic. Some are very detailed. In addition, certain general aviation manufacturers publish annual inspection checklists that are configured to the aircraft and type. Use of these versions is recommended rather than using internally generated documents for inspection activities.

General aviation has been the source of much of the industry's talent and innovation over the last century – from flying kites on a North Carolina beach to privatization of space travel. In spite of the individualistic and family like environments that persist and are the mainstay of general aviation, real skill sets are evolving that are highly effective and professional; not "mom and pop." As we focus on industrial level maintenance activities associated with modern air transportation we can lose sight of that.

The lowly checklist can be used as the vehicle to connect all kinds of information together that paints a picture of effective processes and control on a scale that many in GA can relate to. By using a standardized method for performing aircraft maintenance, we create repeatability in our efforts to maintain and promote the highest level of safety in our operations. **AMT**

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TCAS

Traffic Collision Avoidance System: Avoiding close encounters or worse!

By Jim Sparks

Jim Sparks has been in aviation for 30 years and is a licensed A&P. His career began in general aviation as a mechanic, electrician, and avionics technician. Currently when not writing for AMT, he is the manager of aviation maintenance for a private company with a fleet including light single engine aircraft, helicopters, and several types of business jets. You can reach him at sparks-jim@sbcglobal.net.

Having accumulated several million miles traveling within the world's airways, a frequent occurrence has been overhearing my fellow passengers voice a belief that the air traffic control system must be an organization funded by the railroads to discourage travel by air.

Yet given the total number of flights every year along with the forecast exponential growth in the total number of aircraft entering service, a system or method to help ensure two or more aircraft do not occupy the same space at any given time has to be a good thing and the fact that most close encounters are nothing more than that indicate something is working as advertised.

Midair collisions

Statistics point out the majority of midair collisions happen to those engaged in recreational flying without a flight plan in good weather conditions during weekend daylight hours and virtually all encounters occurred below 6,000 feet.

The flight decks of today provide pilots with an abundance of information which tends to lead to a heads down approach to flying. Undisputedly, many close calls and collisions could be avoided by simply spending more time looking out the windows.

An aircraft collision avoidance system is intended to independently monitor the airspace around aircraft and alert the crew to potential conflicts and has taken on the official title of "Traffic Collision Avoidance System" or TCAS. It involves communications between all in range aircraft equipped with an appropriate transponder and utilizes the same coding as the ground-based secondary surveillance radar (SSR) utilized by air traffic controllers.

The concept is to establish a three-dimensional zone surrounding the TCAS equipped aircraft capable of alerting the pilot(s) to any intrusion of their airspace by another transponder equipped machine. This technology is completely independent of ground-based directives and can monitor all aircraft with an operating Mode C (altitude reporting) or Mode S (enhanced surveillance) transponder. Transponders produce an "Interrogation" transmission utilizing a coded signal on the 1,030 MHz frequency and then wait for a coded response on 1,090 MHz.

A TCAS processor senses for the 1,030 MHz signal produced by all transponders and once this interrogation is noted, the processor will utilize its own aircraft altitude input compared to the decoded intruder altitude to make a determination if advising the flight crew is warranted. The equipment uses pressure altitude, radar altitude, and in some cases aircraft position information to detect threats and provide flight crews with evasive actions.

System installations will include several external antennae with one mounted on the top and another on the bottom of the fuselage. The upper antenna is frequently a directional type that is accurate within about 15 degrees and the lower may be either directional or omni directional. TCAS antennas are separate from the upper and lower blades required for the enhanced surveillance transponder (Mode S). It has been noted that propellers can effectively block at least part of the arc of the directional antenna(s) so a thorough investigation should be conducted prior to deciding on antenna location for new installations.

Hazardous warnings

Once the processor analyzes the transponder interrogations and correlates to aircraft parameters, a pictorial image is produced and sent to the flight deck display. Frequently this presentation will appear on an electronic vertical speed indicator (VSI) but with newer digital flight instruments it is possible to display traffic information in several locations.

Standardized audible advisories have been created and can be reproduced to the crew to draw further attention to a potential hazard. The intent is to produce an image with an alert to enlighten flight crews to all identified traffic within a certain radius of their aircraft. The

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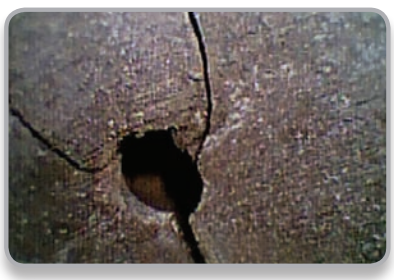

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second feature is to highlight any potential threats. That is, aircraft getting too close or on a collision course at the same altitude.

There are two levels of TCAS: the first or type 1 is for general aviation use. The objective is to provide "Traffic Advisories" to assist pilots in visually locating other aircraft that are intruding in their airspace.

TCAS II is a bit more sophisticated, in addition to locating intruders, type II can provide "Resolution Advisories" (RA) which issue guidance commands both aurally and visually on maneuvers to avoid a potential conflict that could lead to a mid-air collision.

The performance standards of type II were updated and approved in December 1997 and are referred to as "Version 7" by the Radio Technical Commission for Aeronautics (RTCA). TCAS II Version 7 has been scrutinized since its introduction and several anomalies were noted. Events had been reported where flight crews did not respond correctly to the "Adjust Vertical Speed" advisory where they increased rather than decreased the rate of change. In other situations Version 7 software failed to revise the RA when converging aircraft remained within a 100-foot vertical separation. The likelihood of this is aggravated when one aircraft is not adhering to a standard RA maneuver or is following the instructions of a ground-based air traffic controller.

Safety margins

A feature has been added to TCAS II Version 7.1 that will increase safety margins when an intruder aircraft is either not TCAS II equipped or is not following the system generated instructions to avoid a potential collision. Now, when it is detected that an intruder is not responding to the standard evasive action, a reversed RA will be issued by the new logic to steer the alerted aircraft away from the conflict. In addition, Version 7.1 provides a new "Level off" alert which will recommend a 0 feet/minute vertical rate and will not be tied to standard flight levels.

Version 7.1 has been mandated this past March (2012) by Eurocontrol for all aircraft utilizing European Union Airspace that are more than 5,700 kg (12,500 pounds) takeoff weight or those authorized to carry more than 19 passengers. An extended deadline of December 2015 for compliance exists for aircraft certified prior to March 1, 2012 and are equipped with Version 7.0.

Real-time traffic info

Automatic Dependent Surveillance-Broadcast (ADS-B) messages can now be sent from suitable transponders with parameters that contain aircraft identification, present location, and even speed. This technology is referred to as hybrid surveillance and enables TCAS equipment capable of processing this data to significantly enhance the performance of collision avoidance systems. In addition, ADS-B will provide real-time traffic information on the flight deck of even small aircraft but will not include RA or any other recommendation for collision avoidance.

The identity information that ADS-B provides can be used to make the flight deck display resemble the picture viewed by an air traffic controller and will potentially increase situational awareness. With the onset of ADS-B, future plans for TCAS including level III and IV have been shelved.

The FAA has issued Advisory Circular AC 20-151A which provides guidance for obtaining airworthiness approval plus includes definition and description of current and future plans for TCAS.

Ground/flight issues

Operation of on-board collision avoidance systems is predicated on a properly operating transponder. Anytime an aircraft is on the ground, Mode "A" (identification), Mode "C", and Mode "S" should be automatically inhibited. Ground/flight issues are among the more common dilemmas encountered by transponders and subsequently collision avoidance systems. In addition radar altimeters will provide relative information pertaining to height above the ground and are used to inhibit aural TCAS alerts below 400 feet above ground level (AGL) while the aircraft is descending and below 600 feet AGL when climbing.

Most systems do include a self-test feature capable of being initiated by a flight crew member. This will verify the integrity of components, annunciators, symbols, and aural alerts. That TCAS comprise digital technology, built-in tests along with fault logs can often be a friend when diagnosing malfunctions.

TCAS does provide many benefits when it comes to increasing situational awareness for flight crews and along with the benefits come the challenges to people such as AMTs that are tasked with keeping it working.

Having just encountered a three-hour ATC delay on a recent airline trip, I did go to the Amtrak schedule and found that it would take the train about 10 hours (not considering Federal Railroad Administration (FRA) Rail Traffic Controller induced delays) to travel between my required city pairs. Even with a three-hour delay I am still convinced travel by air is the only way to go. **AMT**

ATP Company Profile

ATP is a global company providing knowledge services for the aviation market. Co-founded in 1973 by current CEO, Caroline Daniels, ATP solutions combine innovative technology, industry expertise, and expedited information access and reporting. The company's comprehensive content services and software applications deliver vital knowledge to support the mission critical requirements of manufacturers, mechanics, pilots, schools, governments, operators and carriers worldwide.

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ATP has been recognized by the Federal Aviation Administration (FAA) since the 1970s when the company began equipping Flight Standards District Offices (FSDO) with its first information services. In 1998, ATP won the first competitive contract to provide a Regulatory Information System to the FAA. Today, ATP is one of only six companies qualified and designated by the FAA as a Qualified Certification Consulting (QCC) group.

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Embraer's new Executive Jet Campus in Melbourne, FL, USA for final assembly of the Phenom 100 and 300 light jets.

Embraer's New Executiv ASSEMBLY FA

AMT gets an inside look at Embraer's state-of-the-art campus in Melbourne, FL

By Charles Chandler

Charles Chandler began his aviation career as a junior mechanic for American Airlines and retired after 27 years of service.

Often our own work experience shapes our perspective of the industry, creating a myopic view of our huge, diverse industry. Mine was developed early on while working in the airline industry where work places were often huge old military or manufacturing spaces that were noisy, dusty, hot, or cold depending on the day or season, and staffed by multitudes of seemingly frenetic employees.

This version was soon to be upgraded when Embraer's media relations manager for North America Elisa Donel, invited *AMT* magazine to attend the news media open house on Sept. 6 at Embraer's Executive Jets Campus in Melbourne, FL. Also attended by journalists, magazine editors, cameramen, and the local press, we got a briefing from the executive staff and a guided tour of the campus. We were treated like customers and all questions were answered.

All photos provided by Embraer.

ve Jet CILITY

Our briefing began with a presentation about the "Space Coast of Florida," the Economic Development Commission (EDC) and Embraer's collaborative efforts and negotiations necessary for Embraer to locate the Phenom 100 and 300 final assembly and paint facility and global customer center at Melbourne International Airport.

Embraer S.A.

Embraer is a multinational corporation headquartered in São José dos Campos, Brazil, that designs, develops, manufactures, and sells aircraft and systems for the commercial aviation, executive aviation, and defense and security segments. It is the world's largest manufacturer of commercial jets up to 120 seats, with offices and operations in six countries including the United States for 33 years.

Founded in 1969, Embraer has a workforce of about 18,000 employees and its firm order backlog is around $16 billion (US). In 2004-2005, a 10-year market assessment showed a potential for 8,500 business jets worth $138 billion (US), so in 2005, Embraer formed Embraer Executive Jets to compete in the entry-level and light jet segments with the Phenom 100 and Phenon 300. Its assessment appears to be on track. In a recent web cast, Embraer discussed its 2012 second quarter performance numbers: 20 jets were delivered to the executive aviation market, 17 of those were light jets (seven Phenom 100s delivered from Melbourne, 10 Phenom 300s).

In today's economics those are great numbers but could be better, according to Ernie Edwards, head of Embraer's Executive Jets business. Edwards told Reuters in an interview at the August Latin American Business Aviation Conference and Exhibition (LABACE) in São Paulo, Brazil, that, "Embraer wants 30 percent of the business jet market" and it appears that the Phenom series is the airplane that will help get that 30 percent and maybe more.

Space Coast of Florida and the Economic Development Commission (EDC)

The Space Coast is a region on the west coast of Florida that includes the cities of Cape Canaveral, Palm Bay, Cocoa, Cocoa Beach, Titusville, Rockledge, and Melbourne. The Economic Development Corporation (EDC) is a development organization created to secure Florida's position as one of the global leaders in aerospace research, investment, exploration, and commerce. The CEO for the EDC of Florida's Space Coast is the dynamic Lynda Weatherman whose job is to liaison between legislators and key business sector associations and companies, developing incentives and policies to strengthen Brevard County's and Melbourne's business environment.

According to Weatherman, one of her "most challenging jobs was to convince the EDC to trust her and put together a large package of incentives necessary to attract a very successful aviation company to the Melbourne International Airport, that insisted on remaining anonymous until late in the negotiations."

After careful consideration regarding their long-term business plan and the incentives offered by the Space Coast's EDC, Embraer did select that location for its Executive Jets headquarters. On Dec. 4, 2008, Embraer broke ground for its first U.S. aircraft final assembly plant where Phenon 100 production started in June 2011 with first delivery in December 2011. Phenom 300 assembly began in September; first delivery expected 1Q2013.

On Dec. 5, 2011, Embraer Executive Jets opened its Global Customer Center where Embraer's global customers can design their executive jet's interior using high-end 3-D technology and showrooms with extensive collections of interior finishing materials. The aircraft and interior are certified at the same time. The delivery suites in this facility provide a dramatic back drop for customers to see their completed U.S.-assembled Phenom 100 and in 1Q2013, their new 300.

Then on March 21, 2012, Florida's Governor Rick Scott announced that "Embraer will be adding a new research and development facility. The Embraer Engineering and Technology Center USA will be housed in a 67,000-square-foot facility to be constructed at the Melbourne International Airport on the site of the current Embraer Executive Jets Division Headquarters and final assembly building."

The final assembly facility is bright, air-conditioned, clean and quiet; part of Embraer's commitment to a culture of employee respect and a great place to work.

The Phenom 100 and the 300 are entry-level jets and were designed specifically to compete in the single-pilot executive and business market. The 100 has a capacity for four passengers, the 300 holds six. About 240 Phenom 100s have been sold and there is a nice back order.

This aircraft is what the Embraer staff call a "clean-sheet" design and represents true innovations in business jets. It is not a scaled down version of other company aircraft.

Melbourne Executive Jet Campus and staff

Embraer's Executive Jet Campus houses the Phenom assembly facilities, global customer center, and the future engineering and technology center to be completed in 2014. The tour of the Melbourne Campus was a high-voltage jolt to my mental model of our aviation industry. The Embraer campus was a "green-field project" and all the new buildings and their interior could be featured on the pages of *Architectural Digest*. The assembly facility was like no other that I have ever worked in, visited, or read about.

Working from a "clean sheet" is how Phil Krull, managing director, Melbourne Operation, describes the campus design philosophy. The final assembly facility in particular is bright, air-conditioned, impossibly clean, and quiet. It is a very high-tech facility using the latest computer systems, manufacturing tools, jigs, fixtures, and processes. In a prior phone interview Krull states, "We are justly proud of this facility in which we combined highly educated, high-tech people with advanced production techniques that are on the leading edge of modern aircraft production."

Total staffing as of July 2012 was 208 employees: 164 in the assembly facility and 44 in the customer service center. According to Krull, "We have a very diverse and talented workforce here at our Melbourne facility. Our technicians average about 17 years of experience. We have 160 production employees and 40 of these are former NASA contractors. Some were recruited from competitors, local companies, and different branches of the military.

"Each new hire had four weeks of training that included lean manufacturing processes, continuous improvement concepts, safety, and other technical courses provided in-house and through Brevard Community College. Technicians that operate special tools, fixtures, and machines had an additional six weeks of intense hands-on training at the Embraer Aircraft Manufacturing facility in Gaviao Peixoto, Brazil."

All executives and staff state that "their success at the Melbourne assembly facility was due to the ease of acculturation with their Brazilian counter parts and the exceptional level of teamwork between the two work groups."

Final assembly line

This modern facility can produce both the Phenom 100 and 300 in single-line configuration. Currently 160 technicians working two shifts are producing two Phenom 100s a month and, depending on eco-

Embraer's new Executive Jet Campus in Melbourne, FL, for final assembly of the Phenom 100 and 300 light jets.

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nomics and customer demand, could increase that rate to eight per month.

Production of the Phenom 100 began in June of 2011 and to date, 14 Phenom 100s have been produced and eight delivered. In the afternoon of our tour the executives announced that two more Phenom 100s had been sold that day. This September, the Phenom 300 assembly started in Melbourne, with its first delivery expected in first quarter 2013.

The fuselage, empennage, and wing assemblies for the 100 and 300s are built in Brazil and shipped in very large boxes via sea and land freight to the Melbourne assembly facility. There, assemblers install windows, landing gears, all systems, flight deck equipment, instrument panels, engines, and the customer's choice of interiors and paint scheme. The aircraft components, piece parts, hardware, and support equipment are clearly marked and strategically placed at each of the five assembly stations. The aircraft in work moves one station every seven days.

On tour, I did not see or hear hand drills, impact wrenches, rivet guns, or service units; no aircraft engines running up or planes taxiing by and most notably, no technicians shouting to be heard over the din of it all. The facility appeared to be staffed by a small number of young, diverse assemblers and support specialists who were friendly and usually presented big smiles as we walked by their workstations.

Paperless assembly

The Melbourne facility is conducting the beta test for Embraer's first "paperless" production line and one that "uses leaner, cleaner, and faster assembly processes." I found this "paperless" line concept intriguing. Granted it was a few years back, but my experience

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Technicians use Embraer's Manufacturing Execution System (MES) a computer-controlled, browser-based data collection and reporting system for work instructions, specifications, or data from a component being installed.

in heavy jet overhaul and light manufacturing was that before the aircraft or part could be released for service, the associated paperwork had to equal the weight of the aircraft or part.

When asked for more details, Krull gave us an ample description of Embraer's Manufacturing Execution System (MES). "It is a computer-controlled, browser-based data collection and reporting system that supports RF handheld intelligent devices and barcode scanners. Embraer staff use a tablet and pen stylus for entering and retrieving information when at workstations, in and around the Phenom production line."

Some examples of information contained in the MES system are work instructions, specifications, or data from a component being installed. When the technicians are working away from plane side, they use kiosks with large screens and keyboards. The MES system collects data about process, quality, downtimes, and maintenance.

Krull says that one of the "challenges" was translating all the technical documentation from Portuguese to English. As we toured the assembly area, we saw many assemblers using the MES. In addition to having this technology available, the engineers and production control support staff are located a short distance from the production line.

Mark Miller, production operations manager, was one of our tour guides and when asked how well the assembly process worked said, "There had been a few challenges early on but they had quickly worked through those and now operations were very smooth. Current production was just a bit ahead of schedule."

Charles Chandler, AMT field editor (left) with Phil Krull, managing director, Embraer's Melbourne, FL, operation (right).

He also casually mentions that in December 2011 when operations and flight tests were completed on the first Melbourne-made Phenom 100 pushed out the door, all operating requirements were met and there were zero discrepancies, no squawks. He says that the Phenom had met their expectations and set the bar for quality.

We also had an opportunity to look at the paint hangar and other employee spaces and common areas. The huge negative-pressure paint hangar was exceedingly clean. The employee café and restrooms were just as bright, colorful, and clean and organized as the production floor.

I mentioned my observations of the café and restrooms to Krull and he says that represents Embraer's commitment to a culture of respect for its employees and to ensure that Embraer is a great place to work. As we toured the Embraer campus, Krull pointed out the common areas including ball courts, walking paths, and covered sitting and eating areas.

To paraphrase several of the Embraer Executive Jet executives: "We are American first and foremost but aviation is a global business. We work for a global company that is very successful, has a culture of inclusion and cooperation, builds beautiful products, has competitive compensation rates, and creates great places for us to work."

Maggie Laureano, vice president of human resources, states that one of the corporate goals was to create a happy workplace at the Embraer campus in Melbourne.

After touring Embraer's Executive Jet Campus and visiting with the employees, my mental model of our industry changed considerably. My hope is that the Embraer culture and the facility in Melbourne become the model for future aviation workplaces. I saw quite a few assemblers that looked quite happy working in a quiet, clean, air-conditioned building on small, beautiful jets. **AMT**

Charles Chandler has a Master's of Science Degree in Adult and Occupational Education with a major in Human Resources Development.

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Getting Your Arms Around SMS

To increase the success rate of your SMS take simple small bites to whittle away at the larger task

By DeborahAnn Cavalcante

DeborahAnn Cavalcante earned her Master of Aeronautical Science, with a specialization in Safety Management from Embry-Riddle Aeronautical University in Daytona, FL, and her Bachelor of Science from VA Tech in Business and Risk Management.

The mere thought of developing or implementing a safety management system (SMS), sends shivers through many managers. They view it as an overwhelming task, sort of like eating an elephant. But just as the old cliché goes, the only way to eat an elephant is one bite at a time. It would seem then, that tackling the SMS monster could be made a simpler process by breaking it down into bite-size pieces, and focusing on smaller pieces so that one layer builds and coordinates with another.

As they embark on the SMS journey, many companies will be pleasantly surprised to find that they already have many of the elements of an SMS in place; however, they may not be documented or a direct correlation between policies, programs, systems, and procedures may be missing or nonexistent. SMS tools, like gap analysis tools, prove to be of great value in determining performance gaps, and what actions should be taken to eliminate the gaps, which essentially becomes the design of the SMS.

The challenge to management personnel in many organizations, will be how to transition the available information, (meaning their existing processes and procedures) and their understanding of SMS, into a functional safety management system in the most efficient and effective manner.

Myths and pitfalls

There are some common pitfalls that can get in the way of a successful SMS development and implementation in an organization. An awareness of these factors goes a long way to getting on the right track.

One of the myths I personally encounter in working with companies to help them develop their SMS, is that senior management does not need to be involved, once they give the green light to middle management to go ahead. It is so vital that senior management does not disengage at this point.

Allow me to share what I would consider to be a golden rule which becomes the foundation for SMS success, just as it is for any other initiative within an organization. That golden rule is that the organization's executives must totally "buy in" to the SMS success and remain engaged in the process throughout the entire development and implementation, by committing the time, resources, and effort to development, implementation, and communication that it will require.

Think about it, if the executives of the organization do not take seriously the value of the SMS, how can they expect the employees to embrace the behavioral changes that will be necessary for compliance? This is easily accomplished by conducting regularly scheduled briefings to communicate progress and maintain forward movement. It will be critical for senior executives to motivate middle management, as this is where the accountability for change most likely falls. Lack of motivation coupled with accountability for forward progress at the middle management level will surely doom the project.

Cultural change

A safety management system may require a cultural change within the organization. Organizations with a high risk tolerance may face a greater challenge

in overcoming failure of the SMS. The accepted ways of doing things or "norms" of the organization may be deeply embedded in the culture. If those norms permit workarounds and shortcuts, a cultural change is in order for SMS success. Culture develops over time, dependent on the seniority of employees, rate of turnover, experience level of employees, training, administrative policies and consequences of safety noncompliance, or lack of consequences for safety noncompliance, as well as many other factors.

Changing the corporate culture involves new safety habits that are repeated until they become the new normal. Implementing positive necessary change in these areas is indeed a process and not an event, and must be taken into account when undertaking SMS. Everyone must believe and take part in the process. Some scary choices may need to be made, not exclusive of personnel changes.

The reporting of near misses within the SMS framework should be viewed as opportunities to mitigate or eliminate the risks associated with the near misses, resulting in an enhanced safety culture and environment and improved profitability.

Evaluate cost savings not cost

More than once, I have heard the objection SMS just costs so much. SMS cost is truly that and nothing more if the organization simply copies someone else's manuals and additionally fails to conduct SMS training. An SMS is put into place, but only in a digital file or a hard copy manual gathering dust on the shelf, in addition to possibly not being applicable to the organization as it was someone else's creation for that organization. No one participates, and there is no feedback from management to employees or from employees to management. The whole idea of SMS is to become proactive in reducing the costs of accidents, incidents, and injuries. This approach defeats the whole

purpose; it then becomes true that the SMS really did not improve anything; it just adds another layer of obligation.

In fact, when the SMS is created as it should be, through unilateral brainstorming, input and feedback from all departments in the organization in conjunction with one another, the SMS will more than pay for itself by actually reducing and eliminating accidents, incidents, and injuries which without the SMS in place may have occurred. No one can count the accidents that don't happen; so here is the real question; how much are you willing to allot in your budget for an accident or injury?

Where exactly is the line item cost in your budget for one of your employees losing their eyesight or limb, or possibly an aircraft crash? Until you realize the risk and the cost associated with that risk, you cannot "realize" the price of SMS.

Another reason for what would seem to be a well-organized and effective SMS to fail is not having an administrative policy in place that defines clear expectations and goals. This combined with monitoring, measurement, and continuous improvement is how the organization can determine if the SMS is successful.

I have heard it said "if we do an SMS we are going to get all these bad reports." Yes! Isn't it better to identify and know about near misses before they become actual accidents? This is evidence that the SMS procedures are working!

An organization that is inundated with hazard reports certainly should be drilling down to the root causes of the issues. When employees have had the chance to say "Wow, that was close," the organization is ripe for an accident. The reporting of near misses within the SMS framework should be viewed as opportunities to mitigate or eliminate the risks associated with the near misses, resulting in an enhanced safety culture and environment and improved profitability.

To increase the success rate of your SMS I recommend taking simple small bites to whittle away at a larger task. Starting with the simple steps and perspectives below may help to get your arms around the looming monster that disguises itself as SMS.

- Stay engaged throughout the organization from the very top position in the organization to the new hire employee.
- Determine what processes and procedures (elements of SMS) you have and what you need.
- Document those procedures.
- Link the processes and procedures together by communicating.
- Use reporting to identify and mitigate risks.
- Monitor, measure, and improve your SMS continually.
- View hazard reports as opportunities to enhance and improve safety. **AMT**

DeborahAnn Cavalcante leads Diversified Aviation Consulting (DAC) and has firsthand experience in air carrier operations, private charter aircraft, general aviation operations, military/civilian interface, FBO management, maintenance repair station training, safety training, human factors training, and customer service training. For more information on DAC visit www.dac.aero.

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Human Factors Challenges

General aviation and airline maintenance solutions

By Dr. Bill Johnson

Dr. William Johnson has spent more than 30 years as senior executive and scientist for engineering companies specializing in technical training and human factors before joining the FAA in 2004. He is also an aviation maintenance technician and has been a pilot for more than 45 years.

Airline maintenance organizations, of all sizes, have many programs to help manage human error. Organizations with European Aviation Safety Agency (EASA) repair station certificates have mandatory human factors requirements. Other airlines and MROs, without such regulations, choose to implement human factors programs to reduce human error, ensure continuing safety, and control cost. Addressing human performance is simply, good business. This article looks at eight maintenance human factors challenges and solutions that are working in general aviation (GA) and airline maintenance organizations.

Airline maintenance/MRO organizations and regulations

One might envision airline maintenance organizations (14 CFR Part 121 or 135) or maintenance and repair organizations (MROs) (14 CFR Part 145) as large factories with hundreds, if not thousands, of maintenance workers. Well, that vision is not correct. Aviation maintenance is comprised of a lot of small businesses. Here are some interesting facts:

- Thirty of the 4,100 repair stations that hold a U.S. Part 145 certificate have more than 2,000 employees.
- Fifty percent of the repair stations have less than 10 employees.
- More than 80 percent have less than 50 employees.
- Thirty percent of U.S. repair stations hold EASA certificates.
- Since the larger repair stations have the EASA certificates, one can estimate that more than half of U.S. airline and airline MRO mechanics work both EASA rules and FAA rules.

General aviation maintenance organizations

Some may have an inaccurate vision of general aviation maintenance organizations. They are seldom merely small hangars working at a slow pace. Like airlines and MROs, GA shops are mostly small businesses. They are geographically dispersed and serve considerably more owner-customers than the big guys. GA shops service diverse aircraft types and have more individuals/owners telling them not only to hurry up but also to keep the cost low. These small shops do not have the economy-of-scale, like airlines and MROs, when it comes to investing in equipment, documentation systems, and other business processes.

Similar challenges

Although we have highlighted the differences, when you compare GA to air carrier maintenance there are likely more similarities than differences. Both groups have the challenge of finding, training, and keeping qualified personnel. Both struggle with the challenge of maintaining aging aircraft while staying abreast with the evolving aircraft, systems, avionics, and test equipment technology. Both groups feel the pinch of providing fair wages and benefits while trying to control the cost of every person-hour involved in maintenance. Both struggle to minimize the cost of mistakes and maximize the continuing aircraft and worker safety. Finally, both groups cope with the human factors that affect nearly every challenge listed above.

Shared human factors challenges

In 2010 FAA sponsored a small invited workshop to identify the critical human factors challenges in maintenance. All segments of aviation maintenance personnel assembled to create a list of the "top eight" human fac-

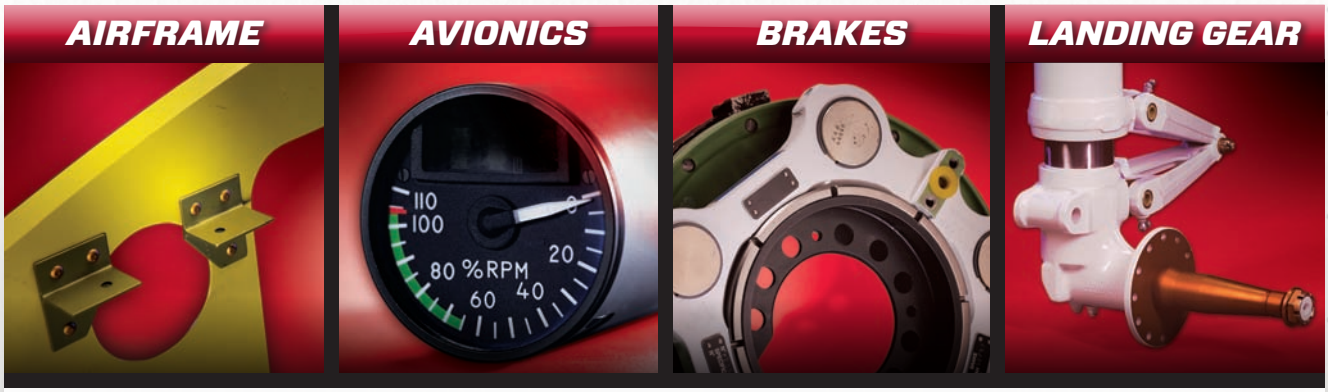

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Table 1.

Top eight maintenance human factors challenges

- Use of Technical Pubs
- Fatigue/Alertness
- Safety Culture
- Event Reporting Data (MEDA, LOSA, ASAP)
- Return-on-Investment
- Establish HF as Priority
- Professionalism (Gen Gaps, etc.)
- Required Inspection Items

tors challenges (See Table 1). By the way, a European group also created a list of maintenance human factors challenges with considerable overlap with the U.S. list. Let's look at airline and general aviation maintenance approaches to these U.S. challenges.

1. Documentation and procedures

Technical documentation and procedures are a big challenge for everyone! It is the No. 1 reason that the FAA takes actions against aviation maintenance technicians, that mechanics complete the NASA Aviation Safety Reports, and that MROs run into errors and reworks. Airlines and MROs work from a combination of manufacturers' publications and company work cards. The challenge is to keep things up to date and to continuously ensure that instructions are compatible. For the MROs it is especially tough because they must use the work cards for each airline customer. There are as many ways to complete a specific task as there are customers.

GA maintenance organizations work on hundreds of aircraft types and models. Each aircraft often has a 30+ year collection of modifications and supplemental type certificates that may need checking. A sign-off for an annual inspection essentially certifies the aircraft and its component documentation for all work since the aircraft was new. One saving grace for GA paperwork is companies like ATP. Such technical publishers assemble the documents from government and manufacturers to streamline the search for proper requirements and procedures. However such companies can only provide the documents. Companies and AMTs must make the commitment to follow the procedures.

Airlines, MROs, and GA maintenance service suppliers must ensure logistical access to readable/usable documents. Availability of documents must be matched with a culture that values following procedures. Individual managers and AMTs can make a difference by always identifying procedures that are difficult or incorrect. Organizations and manufacturers must amend procedures as soon as possible. That action can help ensure that technical documentation is not only high value but also perceived as high value by the maintenance workers that use them.

The combination of insufficient rest, long working hours, and middle of the night maintenance activity has a significant impact on worker performance.

2. Fatigued workers

The workshop delegates ranked fatigue as the second largest risk to safe work. The fatigue challenge may be larger at MROs and airlines but GA is not immune. An FAA study in 1999-2000 collected

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more than 50,000 hours of data from airline maintenance and MRO workers and found that the average sleep was just over five hours/day. A 2006 study of the general American population showed that men get about six hours. Both numbers are well below the recommended eight hours of sleep per day.

The airline maintenance occupation, especially airlines, conducts a lot of night and early morning work. The combination of insufficient rest, long working hours, and middle of the night maintenance activity has a significant impact on worker performance. Since airliners must be maintained during the night the solution can be found in increased sleep duration and science-based scheduling. Other interventions, like napping, strategic use of caffeine, adjusting lighting, and matching rested workers to critical tasks are all partial solutions.

Both airlines and general aviation mechanics have been using the FAA's computer-based fatigue countermeasure training. The two-hour course, available at www.faasafety.gov, has been used by more than 25,000 mechanics. There are a number of U.S. and international MROs and airlines that have made the fatigue training mandatory for all workers. The FAA also provides additional support for fatigue awareness at www.mxfatigue.com.

3. Safety culture

The two words, safety culture, are easy to say but represent attitudes and programs that require significant corporate and individual worker commitment. It is characterized by a shared value in the importance of safety and the ability of every worker to articulate, understand, and perform their individual actions to ensure safety. A five-person GA shop or a 5,000-employee MRO can have a safety culture.

Whether you are maintaining airliners or small aircraft, the safety culture must be communicated from the senior executive level. A safety culture has ways for all personnel to report safety threats, errors, or even violations that may impact safety. The industrywide push for the application of safety management systems (SMS) will eventually have a positive impact on GA.

4. Event reporting data

It is difficult to discuss safety culture and SMS without talking about event reporting.

Safety management is a formalization of the safety process.

To help make safety a priority, we must demonstrate that safety interventions not only improve quality and safety but also lower costs.

It relies on the process of keeping excellent records, observing, and recording company performance. SMS uses appropriate key indicators to understand why something may have gone wrong, or to predict trends of impending issues. SMS can help companies to look at emerging threats using current data. This helps ensure continuing safety.

Airlines and MROs rely on key performance indicators (KPIs) to impact safety and financial decisions. Flight deck technology makes it possible to record every action of the pilot or aircraft. Airlines know the quality of nearly every take-off, approach, and landing. This can help with decision making about procedures, training, crew pairing, and more. Of course, the airlines can also watch engine and aircraft system performance to know temperatures, vibration, fuel flow, and hundreds of other data points. MROs and airline maintenance organizations can count maintenance-caused delays or returns, rework, warranty issues, and more. Even with all of this data, it is difficult to fully identify and understand the contributing factors of a maintenance discrepancy. For maintenance performance, human generated event reports are better than automated data collection.

Airline/MROs use initiatives like the Aviation Safety Action Program (ASAP) to help learn about threats and also about ways to reduce them. These safety initiatives can be scaled to GA maintenance organizations. Boeing has created a process to record a maintenance error and to help find "corrective actions." The Boeing Maintenance Error Decision Aid (MEDA) has been around since the mid-'90s and is used by more than 700 airlines worldwide. Mid- and larger-sized GA maintenance organizations are using MEDA to help support SMS. Other programs, like the new FAA-A4A Maintenance and Ramp Line Operations Safety Assessment (MRLOSA) apply peer-to-peer reviews of normal performance. Scaled to GA, MRLOSA can collect data about threats before they become errors or injuries. Systems like MEDA and MRLOSA are not only a foundation for SMS but also a means to foster a safety culture.

5. Return on investment

Senior executives typically invest in materials or services that will improve the bottom line. To help make safety a priority,

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we must demonstrate that safety interventions not only improve quality and safety but also lower costs. If human factors programs show return on investment (ROI) then they will not be an easy target in lean times. *AMT* (July 2012) discussed ASAP and ROI as an example of how programs can combine to show the impact of HF initiatives.

General aviation and airline maintenance organizations can apply the same solutions. First, make it a priority to identify a few events that warrant corrective actions. Second, determine the cost of the events, the cost of the intervention, and how many events will likely be reduced by the intervention. Third, input the data into the FAA's maintenance ROI software that is available at www.mxfatigue.com. The software is a well-documented easy-to-use set of linked Excel spreadsheets. This author has witnessed numerous maintenance organizations express amazement regarding how easy it is to use. Of course, the hard part is assigning values and event counts to the challenge, the solutions, and the eventual outcome.

6. Establish HF as a priority

There is a wide range of attitudes about human factors programs for maintenance. There are CEOs and managing directors of large and small maintenance organizations that can deliver a speech that promotes the importance of corporate attention to human factors. The same is true about regulators from all ranks. Some deliver heartfelt messages as if they were the instructors of a human factors course. When leadership has the knowledge and commitment it is reflected throughout the organization. That is true for any size company, fixing any size aircraft.

Recently, an international safety consultant commented that, initially, the quality of human factors programs, in the United States, went down after repair stations began following the EASA HF training requirements. He said that he saw many organizations were driven only by the need to check off the regulatory requirement rather than to find value in the HF program. Organizations are now realizing that human factors programs are an important piece of a safety management system.

There is an across-the-board effort to raise the priority of HF programs. The programs must be applied/practical and based on identified company deficiencies and examples. HF practitioners must demonstrate the safety and business case of the programs. The HF programs must become an integral part of the SMS.

7. Professionalism

Workers must be internally as well as externally motivated to "do the right thing." That includes attitudes and behaviors on topics like: uncompromised compliance with company procedures and technical documentation; understanding and adherence to fitness for duty requirements with particular regard for fatigue issues; sensitivity to culture and the importance of workplace communication among diverse ages and nationalities; and other nontechnical and technical behavior and performance. Again, like safety culture, professionalism is contagious. There are no notable differences in the requirement for professionalism between GA and airline maintenance personnel.

8. Required inspection items

The topic of "required inspection items" made No. 8 on the important challenges in maintenance human factors. The reason is that many events in airlines and in general aviation are a result of incomplete inspection. On a risk assessment matrix, a missed inspection is not always ranked as "catastrophic" but it is ranked as a frequent occurrence. The term "required inspection" means just that. The workshop delegates felt that the tasks that require a double inspection are often treated as a normal and routine maintenance task. There is another risk that a mechanic may be lax, knowing that the work would have another inspection. The inspector, on the other hand, may expect that the mechanic was especially diligent due to the importance of the task and because it would get "an extra set of eyes" before flight. The result could be inspector complacency.

What do you need to do?

The solution to the "required inspection items" tasks falls into all of the solutions described in challenges 1-8. The solutions work in GA and airline maintenance environments. And the solutions make a good ending to this article. That includes:

1. Adhere to procedures/documentation;
2. Get proper rest and pay attention to schedules and to time of day/night;
3. Establish and nurture a safety culture that
4. Reports and analyzes data and
5. Demonstrates return on investment;
6. Make human factors a priority;
7. Apply professional behavior to delivery of safe and efficient aircraft maintenance
8. Pay attention to work that requires double inspection.

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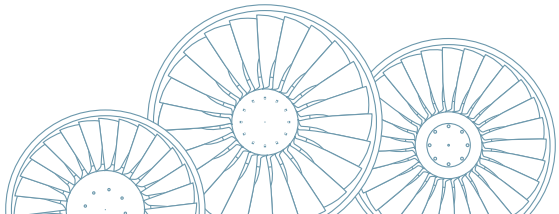

IAs Get Ready for March 31, 2013

New policy rules will be in effect

By Stephen P. Prentice

Stephen P. Prentice is an attorney whose practice involves FAA-NTSB issues. He has an Airframe and Powerplant certificate and is an ATP rated pilot. He is a USAF veteran. Send comments to aerolaw@att.net.

Most technicians with Inspection Authority should know by now that the two-year long controversy regarding IA renewal procedures has been finalized. After receiving almost one thousand comments from technicians in the field, Flight Standards was forced to make serious revisions to its proposed *policy* change. The new "guidance" for FAA safety inspectors (ASIs) and aviation safety technicians (ASTs) has finally been published in what is now called the Flight Standards Information Management Systems (FSIMS) cited as Order 8900.1 Chg. 211, (Vol. 5 Section 8 and Section 7), or better yet, commonly known as the Inspectors Guidance Manual.

This is the bible that is an interpretation of the regulations for use by the inspectors. Up until the last renewal period (March 31, 2009 – March 31, 2011) , the old policy applied … the period of 2011-2012 and renewal on March 31, 2013 starts the application of the so-called new policy interpretation of the regulation and guidance for FAR 65.91c(1) thru (4).

This policy guidance was published and released May 13, 2012, and this writer reviewed his copy during this past August. This timing raises a question of whether or not this revised policy can apply to the past two years … the guidance was not published until May 2012 … does it apply retroactively to the past two years rather than the upcoming two years? Some have questioned this application. Can the policy change apply to a period of time when it was not in existence in the guidance manual, notwithstanding the arbitrary policy effective date published in the *Federal Register* of Sept. 6, 2011?

The new guidance Section 8 of Vol. 5 Chapter 5 is the part that describes the Renewal of Inspection Authorization. Interestingly however, it refers you to Section 7 (Initial Application for IA authority) for further instruction: 5-1309:

Renewal of IA: 1) Show evidence and/or the applicant's ability to meet the requirements of FAR 65.91(c) (1) through (4). Note: Refer to Volume 5, Chapter 5, Section 7, subparagraphs 5-1279A through C for additional information on meeting 65.91(c)1 through (4) requirements during renewals to include actively-engaged guidance.

Note: Refresher training attendance alone does not satisfy those requirements.

The key element that is focused on in this new policy is the actively-engaged part of the requirements for initial issuance of inspection authority.

Somehow, after all the years that IA authority has been in existence, the wizards at Flight Standards in Washington have decided that there should be the same requirement for active engagement in work in both instances, i.e. initial issuance and renewal. (Even though regulation seems to support it.) The reasoning given for all this concern is …"it has caused confusion among ASIs and aircraft maintenance …" We have never found any confusion from any of the technicians we have talked with, however.

You must complete one of the four classic ways to renew, i.e. oral exam, four annuals, eight 337s, or attendance at eight-hour seminar. The change is simply that you now must also meet the actively-engaged part (that is part of the initial application requirements).

Most of the complaints came from IAs

who have been in the business for many years and have either moved up the ladder or reduced their hands-on mechanic work as they grew older. (All of these complaints can be read on the web.) They may have left maintenance as such and did nothing but inspection work which is, needless to say, the function of a mechanic in the first place. Whether or not he actually turns a wrench, IAs are inspectors first and foremost.

Inspectors in industry and indeed in the military are just that, inspectors. I can remember in the USAF we mechanics were in awe of the inspectors because of their power to create more work for us. The inspector was never expected to do mechanic work and at the same time be an inspector.

The FAA has made broad provision for many of these circumstances in its revised policy statement however, and others as noted in the Federal Register and the new guidance cited below.

New renewal requirements

There are basically two requirements now for renewal:

- You must complete one of the four classic ways to renew, i.e. oral exam, four annuals, eight 337s, or attendance at eight-hour seminar. Yes, the eight-hour seminar is still one of the four ways to renew.
- The change is simply that you now must also meet the actively-engaged part (that is part of the initial application requirements). For more than 25 years this has never been a requirement to my knowledge. No renewal applicant has ever been asked for proof that he has done mechanic work in addition to inspection work. This is the new policy change. Go figure.

FAA definition of actively engaged

"Actively engaged means having an active role in exercising the privileges of an A&P mechanic certificate in the maintenance of civil aircraft. Applicants who inspect, overhaul, repair, preserve, or replace parts on aircraft, or who supervise, i.e., direct and inspect those activities, are actively engaged. The ASI may use evidence or documentation provided by the applicant showing inspection, overhaul, repair, preservation, or replacement of parts on aircraft or supervision of these activities."

Many senior IAs assist

the smaller segments of the maintenance business … will they now be forced to spend time turning wrenches … sheer nonsense! Again, they are inspectors, they inspect.

Other significant parts of the ASI guidance manual

In addition, special attention is to be given to the volume of work that you perform … according to the guidance, it says: "... the volume of work performed or quantity of maintenance work activity demonstrates if the applicant (for renewal) was actively engaged …"

Again, we should note that this is "guidance" not regulation. No where in the history of IA renewal, or regulation, is volume of work mentioned as a demonstration of actively engaged (that's the reason there was a reference back to the initial requirements to find it). As a matter of fact, the contrary is clearly stated in the *Federal Register*.

Before this change was effective the policy was well discussed in the description of the proposed change.

In the *Federal Register* Vol. 76, No. 150, for Thursday, August 4, 2011 Rules and Regulations page 47059, it says rather clearly … "the FAA values the substantive nature of experience rather than a strict quantity formula …" This means what it says … substance rather than volume prevails …

And, the *Register* goes on to state … expanding on actively engaged … "The FAA agrees that supervision of maintenance activities provides the same sort of experience that the actively-engaged requirement was intended to require. For that reason, the FAA will include technical supervision and supervision in an executive capacity on either full-time, part-time, or occasional basis in the definition of actively engaged. A technical instructor or a Part 147 school instructor may maintain aircraft or supervise the maintenance of aircraft in addition to instruction, in which case the instruction could be considered actively engaged depending on the activity demonstrated.

Also, procedures in the Guidance at 5-1312 Part B restrict aviation safety technicians (ASTs) and prohibit them from signing off anyone who is renewing based on the eight-hour seminar attendance. That person must be renewed by an aviation safety inspector (ASI).

"An aviation safety technician (AST) not holding an A&P mechanic certificate may renew an IA and sign form 8610-1 block 14 only when the IA has been determined to have met 65.91 and 65.93 (a)(1), (2) or (3) eligibility based on activity for the first and second years. Refer all other IA renewal eligibilities based on oral test or training attendance (eight-hour seminar) to an ASI for determination and Form 8610-1 block 1-14 authorizations. The AST authority with reference to an IA is limited to renewals only and further limited to renewal based solely on activity for both the first and second years."

There seems little doubt that the FAA is attempting to discourage renewal by the use of the eight-hour seminar. It apparently will now give greater scrutiny to one who is renewing by way of a seminar.

Many in the trade have seen this two-year effort on the part of Flight Standards as a colossal waste of money and other resources to effectuate some sort of policy that was not needed and indeed serves no useful purpose, except of course to discourage some senior IAs to pack it in, which may have been the purpose in the first place, otherwise why have the FSDO sponsored IA renewal seminars quietly disappeared? AMT

"The FAA agrees that supervision of maintenance activities provides the same sort of experience that the actively-engaged requirement was intended to require. For that reason, the FAA will include technical supervision and supervision in an executive capacity on either full-time, part-time, or occasional basis in the definition of actively engaged."

— Federal Register

Special attention is to be given to the volume of work that you perform . . . No where in the history of IA renewal, or regulation, is volume of work mentioned as a demonstration of actively engaged (that's the reason there was a reference back to the initial requirements).

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AMTSociety State of the Industry Address

Who do you trust?

According to Webster's Dictionary trust is the "firm" belief or confidence in the honesty, justice, reliability, etc., of another person or thing. When it comes to maintenance and inspections, a question you should always ask yourself is. "Do I trust or have confidence that the previous maintenance or inspection was properly completed?"

Sadly, too many problems and accidents prove otherwise. When removing and replacing a component, don't "trust" that it was properly installed previously. This is especially true if a component requires bench tests, clearance or tolerance checks prior to installation.

Read, understand, and follow the manufacturer's instructions and Instructions for Continued Airworthiness (ICA) rather than installing as it was previously installed. We are human and as hard as we try, we all make mistakes.

When it comes to inspections, carefully and thoroughly inspect every item required by the manufacturer's inspection checklist rather than being pressured to take shortcuts or cut corners to save time and or money. Do you have the firm belief and/or confidence that all the covers and panels were opened and/or removed and areas behind insulation were properly inspected during previous inspections? The truth is, you don't know for sure!

Here is a hypothetical example: Someone replaced numerous missing upholstery screws in an interior side panel. It should be documented, but it might not be. Nevertheless, were the screws too long, and maybe one or even several are now chaffing against a fluid line, hose, or electrical wire behind that panel? You don't know unless you inspect. The firm belief or confidence in reliability comes only after you have performed maintenance and inspection per the manufacturer's instructions and data. Back in the '80s, Ronald Reagan had a phrase he used when dealing with the old Soviet Union, "Trust, but verify." Good advice for all of us.

— Stay safe, Tom Hendershot

Scholarship program

A reminder to all: The date for submission for all scholarship forms and accompanying material is Dec. 15, 2012. Select the scholarship you wish to apply for on the web site, www.AMTSociety.org, complete the form, attach the required information and mail it so that it is postmarked by Dec. 15, 2012 to: Joseph C. Hawkins, Chairman, *AMTSociety* Scholarship Program, 5419 Colonial Circle, Murfreesboro, TN 37129-7038

Lifetime Achievement Award

For those of you who are interested in nominating someone for this award, the nomination form can be obtained from the web site. After you have completed the form, mail it so that it is postmarked by Dec. 15, 2012, to: Thomas E. Hendershot, Executive Director, *AMTSociety* International Headquarters, 13183 Regulus Dr., Lone Tree, CO 80124-2931

Toolbox raffle and scholarship program

Once again, Snap-on Industrial has supported *AMTSociety* with a KRA 4107D toolbox valued at $2,500 and your choice of

Snap-on tools valued at $2,500. The tickets are one ticket for $5 or three tickets for $10. The color of the toolbox is your individual choice, and the toolbox and tools will be shipped to the address you specify. Should you win and decide to donate this toolbox and tools to an A&P school, Snap-on will add $1,000 worth of tools for the school. Tickets can be obtained from any *AMTSociety* director, or you can send me a check for the number of tickets you wish to purchase and I will send the tickets to you (address above). The drawing will be held on Friday, March 15, 2013, during the Maintenance Skills Competition Awards program in Las Vegas. The winner need not be present to win.

Notice

For all of you who are planning on attending *AMTSociety*'s IA Renewal Consortium Program in Las Vegas, NV, at AviationPros LIVE in March 2013: The program will be a one-day meeting. Registration is from 7:00 to 8:00 with the program schedule from 0800 to 1700. *AMTSociety* will host the morning and afternoon breaks as well as lunch. The cost will be $70, which includes a one-year membership, breaks, lunch, the eight-hour course plus the certificate of completion for the FAA. Please don't forget to pre-register at www.AMTSociety.org. The date again: Wednesday, March 13, 2013.

If you have questions, please contact Tom Hendershot, at (303) 799-6870 or (800) 547-7377 Ext. 1565.

2012 – 2013 AMTSociety IA Renewal Consortium Program

Wednesday, Oct. 24, 2012
Doubletree Hotel Mahwah
180 Rt. 17 S.
Mahwah, NJ 07430-1240

Wednesday, Nov. 14, 2012 (SEA)
Holiday Inn SeaTac Intl. Airport
17338 International Blvd.
Seattle, WA 98188-3530

Wednesday, Jan. 9, 2013 (IAH)
Express Jet Airlines
Training Center
17445 John F. Kennedy Blvd.
Houston, TX 77032-6029

Wednesday, Jan. 23, 2013 (ATL)
Doubletree Hotel
Atlanta Airport
3400 Norman Berry Dr.
Atlanta, GA 30344-5111

Wednesday, Feb. 13, 2013 (PHX)
Holiday Inn and Suites
Phoenix Airport
3220 S. 48th St.
Phoenix, AZ 85040-1747

Wednesday, March 13, 2013 (LAS)
Held in conjunction with AviationPros LIVE
Las Vegas Convention Center – Center Hall
3150 Paradise Rd.
Las Vegas, NV 89109-9096

Wednesday, March 20, 2013 (MCI)
KCI Expo Center
11730 N.W. Ambassador Dr.
Kansas City, MO 64153-2056

Wednesday, March 27, 2013 (DEN)
The Summit Conference & Event Center
411 Sable Blvd.
Aurora, CO 80011-8800

Saturday, April 13, 2013 (MCO)
ATEC Annual Meeting and FAA/DME Renewal
Wyndham Lake Buena Vista Resort
1850 Hotel Plaza Blvd.
Lake Buena Vista, FL 32830-8406

$10,000 Charles Taylor goal reached for Wall of Honor

Due to the generosity of individuals and organizations and companies worldwide $10,000 was raised in eight weeks to have Taylor's name engraved with the largest size lettering.

The people who help populate our "society" of aircraft maintenance professionals have recently come together to have Charles E. Taylor's name written on a very prestigious "history book" located at the same Steven F. Udvar-Hazy Center where his likeness is on display.

The Hazy Center has an airfoil shaped memorial that recognizes those with a passion for flight called the Wall of Honor. Lettering ranges in sizes from 3/16 to 1 inch and because of the generosity of individuals and organizations and companies worldwide $10,000 was raised in eight weeks to have Charlie's name engraved with the largest size lettering.

Since mankind conquered the challenge of powered, controlled flight there have been many technological advancements in both airframe and power plant. It is rewarding to know that the craft and profession which Charlie started remembers its past by making sure Charles E. Taylor is not forgotten.

The list of donors is available on www.AMTSociety.org and AviationPros.com.

— Ken MacTiernan

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- January 23, 2013.....Atlanta, GA
- February 13, 2013.....Phoenix, AZ

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- Having trouble registering? Contact the AMTSociety at marketing@amtsociety.org

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Check Twice, Fix Once

Ask your co-worker to look at what you've done and keep track of how to put things back together

By Clint Lowe

Clint Lowe holds an FAA Airframe and Powerplant certificate with Inspection Authorization and a Commercial Pilot certificate with instrument and multi engine ratings.

In 1994 I decided to build a house. With participation in only one fence-building project before that, I had the good sense to find an old, very experienced carpenter to head up the project with me as his pupil in a schooling that's served me well for years since. Among the mountain of wisdom he passed to me during that six-month ordeal was the wood-cutting admonition to "measure twice, cut once."

A recent incident brings to light the critical nature of checking your work twice before you let a pilot have the airplane. It involved a simple generator change on a twin-engine business jet. As with many older aircraft, this one had four wires going to two posts and all of the wires had whatever labels that'd once been on them worn off. The mechanic had done the job many times and apparently decided he could somehow set the wiring aside in some fashion that made sense to him; when the generator was re-installed and the engine cranked a bunch of fuses blew and electrons went into many spaces they shouldn't go. It took another day and a lot of money to get it all right again. Two major errors occurred here.

Basic Mechanic 101

First, when you're getting ready to tear something apart, take a look at the potential problems you'll have getting it back together. Are certain nuts/bolts used in certain spots? Are there wires going to-and-fro that may not be readily identified when putting it back together? This is Basic Mechanic 101 yet we still manage to mess it up. Is it too much trouble to mark and/or bag things properly? Keep a marker, some tape, or whatever you need in the toolbox to make it easier.

But the more important error here was no one else looked at it. During the followup to the fried fuses, another mechanic looked up at the generator and instantly identified the problem; he, of course, found the wires were backwards when he saw it from a different angle. If he'd looked at it before there would have been no issue when the pilot started the plane.

First, when you're getting ready to tear something apart, take a look at the potential problems you'll have getting it back together. This is Basic Mechanic 101 yet we still manage to mess it up. Is it too much trouble to mark and/or bag things properly?

For 20 years, I worked in a jet engine test facility on F-16 engines. When the P&W F-100 engine first arrived, we were briefed in Air Force familiarization class there was a reason the '16 was known as the "Lawn Dart." The earliest version of the engine, the F100-200, had a terrible reliability rate with an in-flight failure every 4,000 hours; they'd get it restarted half the time. At the Hush House test facility, we committed ourselves to doing all we could to prevent engine problems; this paid off when we shared with our engine maintenance people the award from Pratt for flying the F100-200 engine longer without an engine failure than any operator — a forever-

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CribMaster tool control solutions take into consideration all aspects of inventory flow around the facility to maintain a safe, FOD-free environment to ensure that maintenance professionals have the right tool at the right time.

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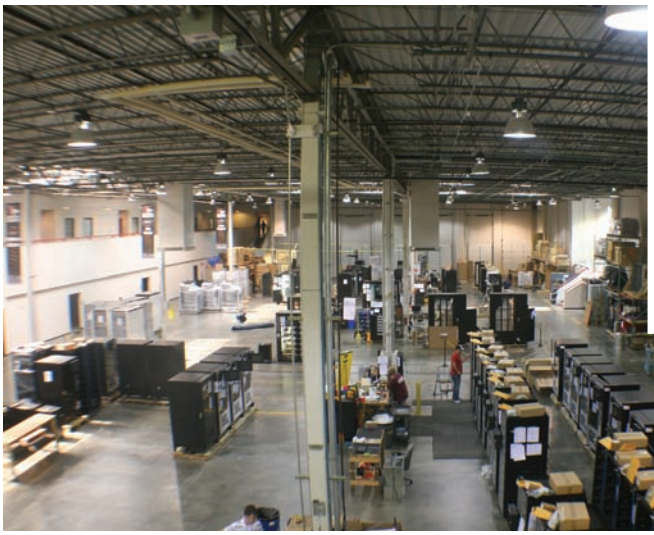
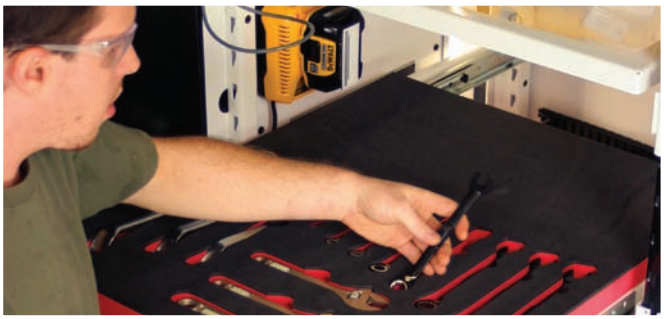
Honored with notable awards such as Boeing Supplier of the Year, Lockheed Martin Small Business Award, and Northrop Grumman technology partner for PM100, CribMaster is proud to offer proven solutions that will impact FOD prevention in aircraft maintenance operations for now and for years to come.





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to-be-unmatched 55,000 flight hours without a shutdown. At conversion to the much-more-reliable F100-220 engine, we'd done what was widely considered impossible. How?

Double check

Among the various habits we developed was the simple process of asking your co-worker to look at what you'd just done. "Hey, Miles, you wanna' take a look at that to make sure I did it right?" Every task, every time.

Sometimes I'd have to walk outside to find one of them. And they'd find problems. I'd find problems. Very small ones, like safety wire in the wrong direction, but each one important. It wasn't a reflection on the other guy's abilities, but instead understanding individuals are fallible. They have fights with girlfriends, they get late on payments, their children get hurt on swing sets, they get dust in their eyes.

Among the various habits we developed was the simple process of asking your co-worker to look at what you'd just done. They'd find problems. I'd find problems. Very small ones, like safety wire in the wrong direction, but each one important.

It is, in fact, a sure sign of a mature mechanic when he/she realizes the lives entrusted to him/her are far more important than their pride. If you know a mechanic that can't stand to be double-checked, then you're working with an immature individual that needs to be watched because their pride is getting in the way of good maintenance practices. 55,000 hours without a failure … good practices pay off.

So we now come back to the wisdom of that old carpenter who showed me how to frame a house. If you have someone double check your work, you direction, but each one important. improve the reliability of your repair. Period. Measure twice, cut once. **AMT**

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Requiem for PMA Parts

Value-added OEM overhaul programs will upset PMA market

By Stephen P. Prentice

Stephen P. Prentice is an attorney whose practice involves FAA-NTSB issues. He has an Airframe and Powerplant certificate and is an ATP rated pilot. He is a USAF veteran. Send comments to aerolaw@att.net.

Just at a time when there is a prime focus on PMA parts approval by the FAA to lend sanity to parts prices, it seems that there appears to be a quiet effort by at least one engine manufacturer to rein-in the use of PMA (Parts Manufacturing Approval) parts and DER (Designated Engineering Representative) approved repairs in their repaired and overhauled OEM engines. This is of course a relatively small effort considering that the PMA market is projected to reach $750 million by 2017, but maybe that is just the point …

The program

This program, so far, by a single major airline engine manufacturer, provides its own method to identify individual engines that contain only their original new or repaired parts. Obviously, it is attempting to provide a specialized value-added service which it claims can better support its engines which have only factory-provided internal parts. Therefore, it says it is in a far better position to evaluate its own engines' configuration and content. It also claims it has the technical data to better evaluate the internal condition of its engines that contain its own factory parts.

Well, everybody knows that PMA parts are usually lower in cost than so-called original OEM parts, keeping in mind, of course, that many OEM parts are also manufactured outside of the OEM facility, many times in far removed remote locations, and at lower cost than their domestic OEM produced parts.

How it works

Once the manufacturer signs up the customer for its value-added program, it will simply examine an incoming overhaul candidate and its records to determine if it contains any PMA parts and if so, the price to overhaul the engine (by the OEM) will suddenly rise or it simply rejects the engine for inclusion in its value-added program. The manufacturer will say that the value of the engine however will increase if all the ersatz (PMA) parts are replaced with OEM parts. (What happens to the PMA parts that are removed is of course probably open to price negotiation.)

It claims that the program is especially useful to leasing companies that intend to resell their aircraft when a lease is up. The idea is that the engines with a lot of PMA parts and or components and DER type repairs will be worth less than the engines with all factory original parts and or factory repairs. The factory parts and repairs would be valued at a higher rate than engines that contain PMA parts and thus the planes should bring a higher price on resale by the lessors.

Once the manufacturer signs up the customer for its value-added program, it will examine an incoming overhaul candidate and its records to determine if it contains any PMA parts and if so, the price to overhaul the engine (by the OEM) will suddenly rise or . . .

Some have suggested that this type of program and any others that attempt to force a customer to use only OEM parts

and repair services, is simply a way to increase revenue. They say that the expected rise in the use of PMA parts is simply being attacked at the factory level in order to protect their market. Of course there are those that argue otherwise and that it is a good program that gives added value to the purchaser. But the question continues to come up … if PMA parts are equal in quality and airworthiness to that of OEM parts (FAA says so ...) then why should engines with PMA parts be treated any differently than engines with OEM repair parts?

Airlines

And, what about airlines? In many cases they have their own maintenance and repair facilities to take care of their engines. FAA and EASA around the world approve PMA parts and repairs for airlines. Virtually all of the top airlines in the world gladly use PMA parts and DER or their own repair procedures. The savings has to be huge considering the costs of factory parts that we all know about. Even a leasing company has to carefully weigh the costs involved with the purchase, at factory prices, of engines, aircraft parts, and factory repairs. It seems clear that if they are willingly paying the increased costs for engine repairs then somebody is going to pay for it … namely the lessee — user. They may have to think twice about who they are dealing with and attempt to discount any increased leasing fees that are designed to offset increased costs for engine repairs.

Furthermore, a PMA parts supplier many times has more efficient resources than the OEM provider and can provide a genuine service alternative. The PMA provider may have superior support service for its product and provide more on the spot technical representatives to the user.

Henry Ford on spare parts

Henry Ford has been quoted as saying. "I'll give you the car for nothing if you agree to buy all your spare parts only from me …." In other words he looked to the long-term relationship with the customer to sustain his business. This kind of service and parts for the life of the car and the parts was fundamental to Ford's success. Likewise, to the PMA market here in the USA and overseas. Most of the major PMA suppliers attempt to follow this rule to the letter with the same kind or in some cases better support than the OEM. But, of necessity, it is limited.

OEM providers, on the other hand, say they provide one-stop service with extended new part warranties, DER, and factory type repairs and of course complete engine overhaul and have all the technical data to do so. Like Henry Ford, they also are seeking that long-term relationship that guarantees the use of higher priced parts.

Presently, recent reports on global PMA parts sales say the market is projected to reach $749 million by the year 2017. But, an engine program like this one does not tend to increase the PMA market. Rather, some would say that it would clearly not support the continued growth of the PMA market and in fact would curtail any further expansion.

Will it grow?

Will this type of factory program expand to the general aviation sector? Engine and airframe OEMs? Many would say that it probably will not … but it is interesting to speculate. It appears that such a program is more suited to the large commercial field of airlines and leasing companies, where there is a huge financial factor to consider. However, many leasing companies will still continue to allow the use of PMA parts as long as the major OEMs

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continue to raise their spare parts prices. With the current state of the economy it seems logical.

There is no question when it comes to whether or not factory OEMs have a virtual legalized monopoly on the sale of their factory parts and services. After all, it's their product and they built it. Through the years attempts to challenge their status has produced little results.

You can be assured that the legal department of the company inaugurating this type of preferential treatment for some has carefully set it up so as to avoid any suggestion of disparate customer handling, or a preferential pricing structure, which might violate some federal or state statute. Nevertheless, there can't help but be the lingering scent of a pricing struggle.

Opposition

You can expect to see and hear strong objections to any attempt to disparage or down-value PMA parts. The PMA parts manufacturers associations are most likely drafting strong positions on the issue. Modification and Replacement Parts Association (MARPA) in particular, will discuss this and other threats to the use of PMA parts, at an upcoming PMA parts gathering in London, UK, this November. According to the schedule, it will specifically bring up the issue as it applies to leasing companies and others, and on how they can effectively deal with manufacturers who attempt to encourage the removal of PMA parts from their products.

MARPA will discuss this and other threats to the use of PMA parts, at an upcoming PMA parts gathering in London, UK, this November.

The threat of some sort of legal proceeding by imaginative lawyers may well be in the future where a theory could be advanced to discourage such attacks on PMA parts. As it now stands, most would agree that such a step is not necessary. Also, there does not seem to be any violation of any federal or state laws where there is only an incentive to remove PMA parts from products. AMT

The Perfect Fit

Over the next 20 years, there will be a need for more than 600,000 aircraft maintenance technicians, according to projections from The 2012 Boeing Pilot & Technician Outlook. Without a highly qualified workforce, whether full-time or contingent, a company can face adversity when trying to scale its business. The costs associated with an unqualified workforce – decreased productivity, high attrition, training, overtime and employment gaps – make it critical that companies invest in a recruitment strategy that attracts and retains employees that are the right fit the first time.

Staffing a Quality Workforce

By staffing a reliable, quality workforce, organizations will ultimately benefit from a workplace environment that fosters productivity and profitability, with overall increased satisfaction with staff. According to a 2011 Aerotek® Inc. study, companies that have high satisfaction levels with new hires have a well-defined recruitment strategy that goes beyond the simple screening and interviewing process. These companies take the time – prior to starting the recruitment and screening process – to define the job role and company culture, develop pre-hire assessments and quantify hiring manager satisfaction.

Not surprisingly, employers who take this approach to hiring a contingent workforce also report a higher degree of satisfaction with their contract hires. Working with a knowledgeable staffing provider can help establish a more efficient hiring process resulting in the recruitment of effective, qualified and loyal contingent workers that can immediately contribute to the overall workforce and the company's business needs.

"The demand for qualified aircraft technicians is at an all-time high. With advances in technology, it has become more critical than ever to provide employees with specific skills and qualifications," said Kirk Hardy, director of Aerotek's Aviation division. "At Aerotek, we take a consultative approach using our Perfect Fit® Program that provides each client with a customized strategy and access to the most talented candidate pool to find the right person that meets their unique needs."

Finding the Perfect Fit

Aerotek, a leading technical, professional and industrial staffing provider, specializes in customized staffing services that fit specific organizational hiring needs. Through more than 200 offices, Aerotek's recruiters and account managers work with employers to fully understand their hiring goals and talent needs. Finding the right employee involves a dedicated team with industry-specific knowledge who perform a full assessment of each role's responsibilities and qualifications, as well as an understanding of the company culture. A thorough screening of talent ensures that candidates are the perfect fit for both the open position and the organization.

A cost-efficient and time-saving solution, Aerotek's streamlined staffing process helps recruit workers with the required qualifications to be successful right out of the gate, so organizations quickly see an improvement in productivity and a return on the investment made in the selection process. Aerotek continually monitors each employee's performance and progress once they are hired to ensure continued success.

For more information on how Aerotek's Perfect Fit Program will benefit your hiring needs, visit AerotekPerfectFit.com or call 1-888-499-9302 to find an office in your area.

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Master Mechanic Awards

Robert Lawson

On Sept. 7, 2012, Robert Lawson of Hoffman Estates, IL, received the Charles Taylor Master Mechanic Award from FAA Safety Team Program Manager Scott Landorf of the DuPage FSDO. Lawson received his A&P license in 1960 after having completed a degree in aviation maintenance from Purdue University. He worked as an aircraft mechanic for Continental Airlines for more than 41 years and retired in 2002. He has continued to perform maintenance on Cessna 150 and Piper Turbo Arrow to the present. In 2003 he earned a private pilot license after having started flying lessons in 1958 in a J-3 Cub.

From left to right: Scott Landorf, FAASTeam Program Manager; Robert Lawson, Master Mechanic Award recipient; and his wife Sharon.

Ted Herron

Ted Herron is an aircraft mechanic for Phoenix Air Group in Cartersville, GA. He was nominated by Cary Roth, one of his co-workers for the Charles E. Taylor Master Mechanic Award. The award was presented to him by the FAA at a ceremony held at the local airport. He is the 20th winner of this award in the state of Georgia.

Jerry Weiler

Upon graduating from high school in 1959, Jerry Weiler began

his flight training in Port Angeles with Angeles Flying Service, where he worked both fueling airplanes, and maintaining them under the supervision of Bill Fairchild and Bill Meyers to pay for those lessons. He earned his private pilot license in 1961, then his powerplant mechanic license in 1962, followed by his airframe rating in 1963. In 1962, he opened his own aircraft maintenance shop, Weiler's Aircraft Maintenance. He worked there continuously until 2005, when he sold his business to Rite Bros. Aviation. He then continued working at Rite Bros. Aviation.

Weiler exemplifies the consummate aviation professional. He has the highest ethical and professional standards. He is meticulously thorough in his inspections, repairs and maintenance of aircraft. He is a pillar of the community, and a legend in aircraft maintenance in this area. His work ethic, at almost 70 years of age, is still amazing, running circles around those decades his junior. His knowledge of FAA regulations, procedures, acceptable methods, and practices pertaining to aircraft maintenance gained over more than 50 years is truly remarkable. He is a role model to all of us.

Charles Reynolds and his wife Marianne with his Charles Taylor Master Mechanic Award.

Charles Reynolds

Charles Reynolds' fascination for airplanes started not long after the end of WWll, at about age six. He lived in North East

Portland and from his upstairs bedroom window with the aid of binoculars, he could see the Portland Airport. After his family moved to Washington, he worked at a local FBO, soaking up all he could. On Aug. 26, 1969, he got his A&P certificate and went to work for Trans World Airlines in Los Angeles, that same week. He was a line mechanic maintaining Convair 880, Boeing 727, all series of Boeing 707's and Boeing 720 B, Boeing 747, and Lockheed 1011 aircraft. Then he went back to Longview, WA, and the FBO at the Kelso Airport and earned his IA. After that he worked on helicopters at Soloy Conversions. From there he followed a mentor to the FAA and served as Aviation Safety Inspector, General

Charles Reynolds and FAA Inspector Patrick Paden

Aviation, Airworthiness, for the Seattle Flight Standards District office in Renton, WA.

"Aviation Maintenance is a wonderful career," Reynolds says. "I have no regrets and I have met many fine people along the way. I love aviation to this day and always will. My intent is to remain active as long as I can and doing whatever I can in the field of aviation maintenance."

GA in Indonesia

ExecuJet Aviation Group and P.T. Dimitri Utama Abadi have signed a joint venture agreement to manage General Aviation Terminals (GAT) at up to 13

The Space Shuttle Endeavor's final flight in September included a stop in the LAX United maintenance hangar; shown with AMTSociety Director Mark Collins. It was on its way to the California Science Center

airports in Indonesia. P.T. Dimitri Utama Abadi is a new private company, formed to serve as the Indonesian partner for the joint venture P.T. ExecuJet Indonesia. The agreement was signed by ExecuJet Asia's Managing Director Graeme Duckworth and P.T. Dimitri Utama Abadi's CEO Soetikno Soedarjo. The joint venture follows the signing of a Memorandum of Cooperation between ExecuJet and Angkasa Pura 1 in May 2012, to design, construct and manage the GATs.

Remote control LED light

Larson Electronics' Magnalight.com adds the GL-9049-24V LED Golight to its inventory of remote controlled spotlights. This high power spotlight combines the long life and high efficiency of LED

technology to produce a powerful and reliable lighting solution capable of operating within a wide variety of professional applications. Producing 2,520 lumens and capable of throwing a light beam over 900 feet in length, it is designed to provide extreme reliability while allowing operators to remotely control on/off operation and vertical and horizontal movement from up to 100 feet away. For more information call (800) 369-6671 or visit www.magnalight.com.

HAECO and Cathay Pacific form joint venture

Hong Kong Aircraft Engineering Company Limited (HAECO) and Cathay Pacific Airways have teamed up to form a joint venture company, HAECO ITM Limited, in Hong Kong to provide inventory technical management services to Cathay Pacific, Dragonair, as well as other airline customers. HAECO ITM services primarily cover provisions and pool management of components inventory, management of component repairs/overhaul and engineering/reliability, supply chain management, and 24/7 AOG support.

HXITM, 70 percent/30 percent owned by HAECO and Cathay Pacific respectively, will be managed by HAECO, with staff from the existing HAECO ITM business and Cathay Pacific Engineering, combining the technical expertise and operational excellence from a leading airline group and a top-tier aircraft engineering service provider. The joint venture will take over HAECO's existing aircraft component assets, and combine it with Cathay Pacific's existing inventory, to support airline customers.

For all the latest products and industry news, go to www.AviationPros.com.

Coming in the Next issue of *AMT.*

In the November/December 2012 issue of AMT learn about 5S, the name of a workplace organization method that uses a list of five primary phases all beginning with the letter "S". This method applies best practices when organizing a work space for efficiency and effectiveness and sustaining the new order.

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OEM or PMA Parts – Is There a Difference?

PMA parts undergo the same rigorous approval and quality control process as OEM parts

By John Goglia

John Goglia has 40+ years experience in the aviation industry. He was the first NTSB board member to hold an FAA aircraft mechanic's certificate. He can be reached at gogliaj@yahoo.com.

It's not just aircraft owners that ask whether parts manufacturing authority (PMA) parts are as good as original equipment manufacturer (OEM) parts. Many mechanics believe that OEM parts are better and that PMA parts are just not as good. They just don't want to use PMA parts in the aircraft they are maintaining if OEM parts are available.

Even though PMA parts undergo the same rigorous approval and quality control process as OEM parts, it is obvious to me that many mechanics remain skeptical. When I talk with mechanics — especially general aviation and corporate mechanics — there seems to be a lingering concern that parts produced by the OEM must be better than those produced under a PMA.

Price difference

Part of the concern appears to be the fact that — in general — PMA parts can be bought for substantially less than OEM parts. The price discrepancies between PMA and OEM parts seem to create the perception that safety — and quality — must reside in the higher-priced product. After all, they've said to me, what other reasons could there be for the differences in price?

Well, there are a lot of reasons for the differences in price — which I won't go into here — but none are related to the safety or quality of the parts themselves. But I understand why mechanics have these lingering concerns.

Many of them arose during the unapproved parts scandals that were prevalent in the industry a number of years ago — and that continue to be a threat to aviation safety warranting appropriate vigilance. *Unapproved* parts were frequently available at significantly lower costs than approved parts — and the safety and the quality of those parts were unacceptable for use in aircraft. But PMA parts are *approved* parts and are appropriate for use in aircraft maintenance, just as OEM parts are. The FAA oversees the production of both in the same manner.

No difference in safety

In addition, my experience after almost a decade as a member of the National Transportation Safety Board is that there is no safety difference between OEM and PMA parts. I am not aware of any accident or incident where a properly approved PMA part was deemed to be a causal factor. I am also not aware of any difference in reliability or durability or any other quality-related factor. I would certainly like to hear from any of you who have experienced differences in OEM vs. PMA parts.

The price discrepancies between PMA and OEM parts seem to create the perception that safety — and quality — must reside in the higher-priced product.

I have also had mechanics tell me that they prefer to use OEM parts because it is less time-consuming for them. That is, if they use an OEM part they don't have to do as much work to ensure that the part being used is approved for the aircraft or aircraft product they're installing it in. That is true to a certain extent — if the OEM and PMA part numbers are different, a little extra checking is required to ensure that the correct part is being used. But if the cost of maintenance is a concern, PMA parts should be explored as an alternative to OEM. AMT

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