



# BRACING FOR CHANGE

Compliance challenges continue to hover over Southwest Airlines two years after missed fuselage inspections triggered an almost \$8 million fine against the carrier. The fall-out from the episode revealed blatant abuse of the FAA's voluntary disclosure programme on both sides, leading to a top-down review of the airworthiness directive compliance programmes, and an acknowledgement that complexity needs to be eliminated from the process. Huge changes are also afoot in US military maintenance, with the air force reversing a decade-long commitment by the Department of Defense to outsource logistics support for weapon systems. Performance-based logistics deals for the C-17 and F-22 will be cancelled, and the work brought back under air force control. Meanwhile, manufacturers continue to make strides in real-time diagnostics.



**PASS inspectors say the Southwest fallout has led to them spending more time in the field**

**MAINTENANCE**

# Comply or don't fly

The changing culture between the FAA and Southwest inspectors highlights issues in the pair's rocky relationship

**LORI RANSON** WASHINGTON DC

**T**wo years after an investigation into the blatant abuse of voluntary disclosure by the US Federal Aviation Administration and Southwest Airlines, the FAA has ushered in a philosophy change to dissolve any notion that

airlines are the agency's customers.

Evidence supporting that new philosophy is most clear in the number of fines issued against carriers this year alone. The FAA has proposed a total of roughly \$8 million in fines against American Airlines, American Eagle and Delta Air Lines. The carrier also aims to fine repair station GE Caledonian \$1.2 million for performing improper maintenance procedures.

While some of the fines were borne out of violations that occurred several years ago and took time to adjudicate, the events of April 2008 and the new mindset of FAA Administrator Randy Babbitt have resulted in the agency creating new levels of accountability to eradicate the cozy relationships US legislators accused the FAA of having with carriers in the aftermath of Southwest in 2007 operating 55,971 flights with 46 aircraft, without com-

pleting required checks for fuselage cracks.

Inspectors overseeing the compliance of Southwest that allowed the carrier to improperly use the voluntary disclosure process to operate noncompliant aircraft "didn't do the job the way we want them to do the job", says FAA manager of flight standards certification and surveillance David Gilliom.

Any reference to airlines as customers has been removed from policy documents, says Gilliom, who adds: "It has been made clear," the relationship between the FAA and airlines is "not what a normal customer relationship might require".

Prior to Babbitt being sworn in as administrator in June 2009, the FAA operated largely under a "carrier friendly" scheme, says Professional Aviation Safety Specialists (PASS) vice-president Linda Goodrich. The message from the agency's executive level sent to managers out in the field was to "do what makes them [airlines] happy. No doubt that translated into not interfering as much as possible." But with the events of two years ago, "that culture has radically changed," she says.

Another shift in oversight stemming from the lapse of inspections at Southwest is structural changes in how inspectors apply the air transportation oversight system (ATOS.) Introduced almost 12 years ago, ATOS shifts how the FAA conducts oversight from purely using inspections to verify compliance with regulations to identifying risks within an airline's maintenance systems to stave off accidents or incidents before they occur.

But the transition to ATOS has been fraught with difficulties, with inspectors arguing managing the ATOS workload has resulted in dramatic cuts in time they spend in the field conducting hands-on inspections.

In June 2008 the US Department of Transportation's inspector general determined that >>

## US AD COMPLIANCE – TWO YEARS OF UNPREDICTABILITY

■ **MARCH 2008**

FAA proposes a \$10.2 million fine against Southwest for operating 46 of its Boeing 737s on 59,971 flights without checking the fuselages for cracks required under an airworthiness directive (AD) published in 2004.

■ **FAA orders US carriers to conduct in-depth audits of compliance with 10 ADs.**

■ **APRIL 2008**

American Airlines grounds its MD-80 fleet and cancels roughly 3,000 flights after the FAA-mandated review of AD

compliance shows the carrier's non-compliance with spacing of retention clips on certain bundles of wiring.

■ **SEPTEMBER 2008**

The Independent Review Team tasked by the Department of Transportation releases the results of its review of FAA oversight and its recommendations to change FAA culture, simplify AD compliance and improve the integrity of voluntary disclosure programmes.

■ **MARCH 2009**

Southwest settles the proposed

\$10.2 million fine by FAA to \$7.5 million, after agreeing to make changes in safety related requirements.

Southwest also hires a consultant to undertake a review of its regulatory compliance and its adherence to the Air Transport Oversight System.

■ **AUGUST 2009**

Reports surface alleging Southwest of using unapproved parts on a number of aircraft. Eventually the carrier determines the parts were used on 82 aircraft, and FAA gives Southwest a December deadline to

replace the parts.

■ **SEPTEMBER 2009**

FAA unveils a search for an individual to head its newly-created Office of Audit and Evaluation designed to handle whistleblower reports and passenger safety complaints.

■ **NOVEMBER 2009**

FAA officially proposes a rule requiring a "cooling off" period before airlines, repair stations, flight schools and other certified entities could hire former FAA aviation safety inspectors that had any direct oversight of the certifi- >>

» missed ATOS inspections on numerous occasions resulted in compliance issues in the Southwest maintenance programme to go undetected for several years. At the time the carrier did disclose the missed fuselage inspections, the IG determined that the FAA had not completed 21 key inspections at Southwest in at least five years.

The weaknesses in ATOS and the workload pressure expressed by inspectors following the Southwest violations resulted in the FAA conducting a time-and-motion study of ATOS.

Goodrich of the PASS union says inspectors do have more authority to spend time in the field after the FAA's study showed that inspectors were spending roughly 15% to 20% of their time on administrative requirements of ATOS. As a result, "inspectors are being encouraged to get out and do more."

The FAA has a slightly different interpretation of ATOS results. "So much was said about inspectors not getting out in the field," says Gilliom. But the agency's ATOS study exposed some misperceptions in the rhetoric so that time in the field was compromised, he says.

However, after the Southwest episode heightened scrutiny over the workloads created by ATOS, Gilliom explains the FAA's study showed some redundancies existed in the system, and in June 2009 the agency completed its plan to streamline the process. Now he says roughly one-third fewer elements exist in inspector requirements to carry out ATOS.

### DISCLOSURE

Initiatives are also under way to combat the abuse of voluntary disclosure exposed by Southwest and the inspectors overseeing its compliance. Gilliom says to prevent airlines operating noncompliant aircraft, both a principle inspector overseeing an airline and an office manager must sign off on a disclosure. Additionally, an individual with a higher level of authority at an airline must also acknowledge and sign-off on the disclosure.

But challenges remain in creating an environment where office inspectors feel comforta-



**FAA had not completed 21 key inspections at Southwest Airlines in at least five years**

ble reporting genuine safety concerns, warns Goodrich. The FAA has created the safety issues reporting system (SIRS) to allow inspectors to elevate safety concerns if the initial response from their supervisor is unsatisfactory.

Goodrich says that if an employee raises a concern beyond his or her immediate manager, the office is still investigated and the employee remains a target for contempt by supervisors. A significant number of inspectors are also concerned the issues raised through SIRS are being "closed out" in name only, she says. In her role at PASS, Goodrich visits roughly two FAA field offices per week, and "the feedback is that [SIRS] is useless."

Despite those concerns, the FAA and inspectors agree with taking a rational approach to compliance with airworthiness directives. A report published by an Independent Review Panel commissioned by former DoT Secretary Mary Peters states the grounding of American Airlines' MD-80 fleet during a three-day period in April 2008 "led many to suggest that the FAA over-reacted, and that the disruption to American's schedule was unnecessary."

After Southwest's noncompliance emerged, the FAA quickly ordered a nation-wide audit of carrier AD compliance. During those audits the FAA discovered discrepancies in the spacing ties on wire bundles in the landing gear bay of American's Boeing MD-80s.

Virtually all airline officials interviewed by the independent review team and many within

the FAA "believe the agency's actions represented a substantial departure from business as usual, and that the agency used an uncommonly literal interpretation of the AD," said the panel in its final report.

Goodrich says that after those events "there was deep concern over did we take it too far?"

American adopted an alternative method of compliance (AMOC) for use in the AD that triggered the groundings. The FAA's former director of flight standards services and current aviation services advisor Jim Ballough explains the agency is working to "give inspectors the tools they need not to make decisions in a vacuum," regarding compliance and AMOC adoption.

With roughly 250 ADs issued annually, Ballough says the agency is also considering assigning a "category one" rating to more complex directives, with an accompanying compliance planning process put in place.

Yet even after the industry was forced into a top-down review of compliance, the airline that triggered the storm of controversy continues to face challenges. Since the events of 2008, Southwest last year discovered aircraft in its fleet operating with unapproved parts, and the FAA is investigating certain fuselage repairs made by a third-party for the carrier.

The FAA's Gilliom says a complete turnaround has occurred in upper management of the agency's Southwest region overseeing American and Southwest. But the person responsible for uncovering the unbalanced relationship between Southwest inspectors and the FAA, whistleblower Charalambé Boutris, has issued a warning to the US Office of Special Counsel about FAA management: "There is no accountability throughout the ranks."

Independent review team panel member William McCabe says: "You need absolute clarity and accountability, and it is hard for management to consistently achieve that".

A significant cultural element exists in all these issues, says McCabe. "Are you more enforcement oriented or collaborative oriented? Too much in either direction creates problems. That is why you need a strong manager." ■

» cate holder in the previous two years.

#### ■ FEBRUARY 2010

FAA confirms its inspection of another Southwest maintenance incident involving repairs to fuselage skins.

#### ■ FEBRUARY 2010

The Inspector General of the US Department of Transportation releases a review of the maintenance programme at American Airlines after a complaint that included 10 maintenance related allegations including a failure to follow procedures required

for maintenance inspections.

#### ■ MARCH 2010

FAA proposes two separate fines against American Airlines of \$787,500 and \$300,000 for maintenance violations after issuing two fines the month prior against American's wholly owned regional subsidiary American Eagle totalling roughly \$5.4 million.

■ The US Office of Special Counsel submits a report from the Inspector General to US President Barack

Obama confirming a second set of allegations expressed by the original whistleblower that Southwest and the FAA inspectors overseeing its maintenance programme misused the voluntary reporting process after Southwest discovered it failed to comply with an AD involving window fasteners on 55 Boeing 737s. Southwest operated six uncompliant aircraft during a two-week period in 2007.

#### ■ MARCH-APRIL 2011

FAA's target to fully implement the

National Air Carrier Evaluation Programme that independently reviews airline compliance. The teams are comprised of agency inspectors. The agency is currently reviewing compliance at two carriers.

#### ■ SEPTEMBER 2011

FAA's target complete changes the AD compliance process after an aviation rulemaking committee completes its review of recommendations proposed by two teams to improve carrier compliance.

**CONTROL**

# Policy shake-up

After more than a decade the US Air Force makes a 'paradigm shift' in its outsourcing strategy for the C-17 and F-22

**STEPHEN TRIMBLE** WASHINGTON DC

The US Air Force is taking back control of maintenance functions for the C-17 and F-22 previously outsourced to Boeing and Lockheed Martin.

The USAF confirmed to *Flight International* in early April that Lockheed's performance-based logistics contract for the F-22 will cease, ending months of speculation about the potential re-insourcing move.

That confirmation came only three months after the USAF announced that Boeing's performance-based logistics deal for the C-17 also would be stripped away.

In those two strokes, the USAF reversed more than a decade of policy momentum building in favour of such long-term outsourcing deals, and threw into doubt a pillar of projected profit growth across the defence industry.

"It is definitely a paradigm shift," says Gus Urzua, vice president for Boeing Globemaster Sustainment Partnership, the branded name for the C-17's PBL contract with the USAF and several foreign customers.

While the change means forcing a new business model on the C-17 and F-22 contractors, it also means the end of guaranteed aircraft availability at a fixed rate for operators.

"I can't provide guarantees if I'm not pulling the strings," Urzua says. "It will become more of a subsystem PBL for Boeing. Instead of being the whole weapon system and guaranteeing aircraft availability, Boeing will guarantee a supply system that is robust and responsive."

The policy shift also comes after a decade of near-universal accolades for the PBL concept, including specifically for the C-17 and



U.S. Air Force photo/Master Sgt. Kevin J. Gruenewald/Released

**An F-22 Raptor canopy being installed at Andersen Air Force Base, Guam**

F-22 deals. The latter was singled out for an award in 2008 by the USAF, or less than two years before the service terminated the deal.

"For the F-22, the USAF initiated the sustainment business case analysis [BCA] due to several factors," a USAF statement says. "First, a previous PBL 'Business Case' recommended a BCA at this point in the program.

## **"I can't provide guarantees if I'm not pulling the strings"**

**GUS URZUA**

Vice-president for Boeing Globemaster Sustainment Partnership

Specifically, our program is in transition from development and production phases to an operations and support phase. Additionally, logistics support cost has grown so the USAF needed alternate options available to control and reduce F-22 operation and sustainment costs."

For its part, Lockheed issued a press statement reiterating the company's belief that a PBL contract gives "essential aircraft availabil-

ity at the lowest possible cost".

In terms of acquisition history, the idea of performance-based logistics contract is a relatively new concept. It has its roots at the lowest point of the defence-spending downturn of the late-1990s, and flowered as the Pentagon embraced outsourcing at the peak of the last decade amidst a historic spending boom.

"The pendulum was on side in the late 1990s, and the pendulum has swung all the way to the other side right now," Urzua says.

The beginning came with the passage of the Fiscal 1998 national defence authorisation act, in which the US Congress authorised Pentagon officials to consider alternative ways to support the upkeep for weapon systems.

Until then, the DOD employed two traditional mechanisms to support products, which actually remain commonplace today despite the performance-based trend.

One traditional approach involves outsourcing, but is far more simple than the performance-based model. The military simply sends a component or system to a supplier for repair or service, along with a bill covering the

» vendor's cost plus a profit fee.

The same role is also performed by any of dozens of government-owned depots. Depots are a relic of the World War II mobilisation, but remain in place to ensure the DoD has the ability to support its own weapon systems during times of war.

The depots also create thousands of jobs, a fact not lost on Congressional-level politicians. Around the same time that lawmakers incentivized the Pentagon to seek out alternative support models, Congress also increased the amount of work required to be performed at government-owned depots to 50%.

Only the USAF has ever breached the 50% threshold since that time – in 2000 and 2001, although the Government Accountability Office has frequently complained about the difficulty of obtaining accurate estimates from the Pentagon.

Despite the pressure on the services to make sure depots received at least half of the sustainment budget, the usage of performance-based logistics deals after 1998 soared. With the results of a handful of pilot programmes available, the incoming Bush Administration in 2001 embraced the concept. The Quadrennial Defense Review that year established performance-based logistics programmes as the military's preferred approach to sustaining weapon systems.

The policy change produced results quickly, according to a 2009 study by the consulting firm Deloitte & Touche. Spending by DOD on performance-based logistics deals in-

creased from \$1.4 billion in 2001 to \$5 billion in 2009, a 17.2% compounded annual growth rate, the study says.

Deloitte & Touche expected the rate of growth to decline after 2009, but still increase at a 10% compounded annual rate through 2013, even as other categories of defence spending, such as procurement and research and development, are expected to freeze or decline.

"This is due to the need for the US Military to bring costs down and to improve dispatch reliability," the study notes.

Simultaneously cutting costs and boosting performance is the elusive 'win-win' scenario

### **"Part of [the Pentagon's doubts about PBLs] is being uneasy with not owning your own destiny"**

**HAL CHRISMAN**

Principle consultant at AeroStrategy

of government contracting, but it was in fact the two selling points for performance-based logistics. A PBL contract allows the military to purchase support as an integrated package. Rather than simply repair components, the contractor would guarantee the availability of an entire fleet.

Structuring the PBL contract with the right incentives also should reduce the cost of sustaining the weapon system.

Such an arrangement "aligns the incentives

of the entity doing the work to improve the performance of the platform", says Hal Chrisman, a principal consultant at Michigan-based AeroStrategy. "You can make more money under a PBL if you improve the reliability of that platform."

Embracing the performance-based approach seems easy, but there is a cost. The government shifts the risk of fleet availability to the contractor, but accepts a loss of control both in day-to-day parts management and long-term budget.

To guarantee fleet availability, the contractor must have absolute control over replacement schedules and inventories. Sometimes, upfront costs can actually increase under a PBL.

Chrisman says a good example occurred with the US Army's helicopter engines. The contractor maintained the engine to a higher specification than the government depot. Near-term maintenance costs increased, but the engine's time-on-wing metric also jumped, which lowered the overall sustainment cost for the engine.

At the same time, performance-based deals are usually structured over several years. This requires the government to commit to certain levels of usage and cost several years in advance.

"Part of [the Pentagon's doubts about PBLs] is being uneasy with not owning your own destiny and not controlling your own destiny," Chrisman says. "There's probably some truth to that."

The concerns about PBL deals extend beyond issues of control. The congressional mandate to devote at least 50% of sustainment work also could be a major factor in the USAF's decision.

Urzuva notes that the policy changes were made a few years ahead of the introduction of the Lockheed F-35, which relies on a contractor-led PBL system, and the planned retirements of hundreds of fighters, tankers and airlifters from the USAF inventory over the next five years. Those trends could start upsetting the carefully managed balance between contractor and government.

Under the terms of the new arrangement, the USAF will set up a hybrid model that includes a combined programme office in 2012 based at Warner-Robins Air Logistics Center, Georgia. Although Boeing will no longer lead the programme, Urzuva will move from Long Beach, California, to Georgia during the transition.

Both sides must be concerned that breaking up a contracting approach proven to work for an untested hybrid system could backfire, with aircraft availability declining despite strong operational demand.

"The last thing they want to do is have fleet degradation because of this," Urzuva says. "They want to make sure this fleet isn't going downhill just because this is happening. ■"



**A C-17 Globemaster III undergoing maintenance**

**ENGINE DIAGNOSTICS**

# Trend setting

GE Aviation's prognostics health management tools are improving safety as well as cutting costs, shop visit time and disruptions

**JOHN CROFT** WASHINGTON DC

**A** bustling engine remote diagnostics business at GE Aviation is fuelling a new family of prognostics health management (PHM) tools to further boost safety while cutting disruptions, maintenance costs and shop visit durations.

The evolution – exemplified by the new engine diagnostics system for the GENx family of engines for the Boeing 787 and 747-8 – is one aspect of a broader push within the industry to begin offering similar gains for a variety of subsystems, including flight software.

GE today is monitoring close to 22,000 engines in operation, nearly 90% of the total number of GE and CFM56-family engines in the field. CFM is a 50/50 joint venture between GE and Snecma, a Safran subsidiary.

Of the engines covered by the diagnostics program, about 75% are in the “standard” diagnostics service category; the other 25% are in the for-fee “comprehensive” program, says Lorenzo Escriche, manager of advanced technology operations and prognostics health management for GE Aviation. GE in 2006 made the basic diagnostic service free for all engine owners, greatly increasing the number of engines covered by the program and statistical value of the database.

Escriche says the savings possible with engine diagnostics varies by platform, for example the CFM56-3 doesn't have the data available as later CFM56 models, but a good “ballpark” number is about \$6.00 savings for per engine per hour for the standard no-fee service.

As many as six “trend points” are sent to GE, the operator or to both, using ACARS digital data messages from an aircraft via the Arinc or SITA networks, including snapshots for takeoff, cruise and when any preset limits or thresholds are exceeded. The engine parameters, collected by the aircraft's central aircraft condition monitoring system (ACMS) and packaged in a single 3.2kb ACARS message, include exhaust gas temperatures, fuel flow and core speed as a function of the fan speed, parameters that indicate the health of the engine's “gas path”.

After “normalising” the data based on Mach number, altitude, pressure and inlet temperature, GE's trending analytical software



The next step for engine diagnostics will soon go live with the GENx-1B (pictured) and -2B

compares the values to previously collected data that is considered to be “normal” data, culling parameters that are out of family for further investigation. Escriche says the normalisation process cuts data scattering, reduc-

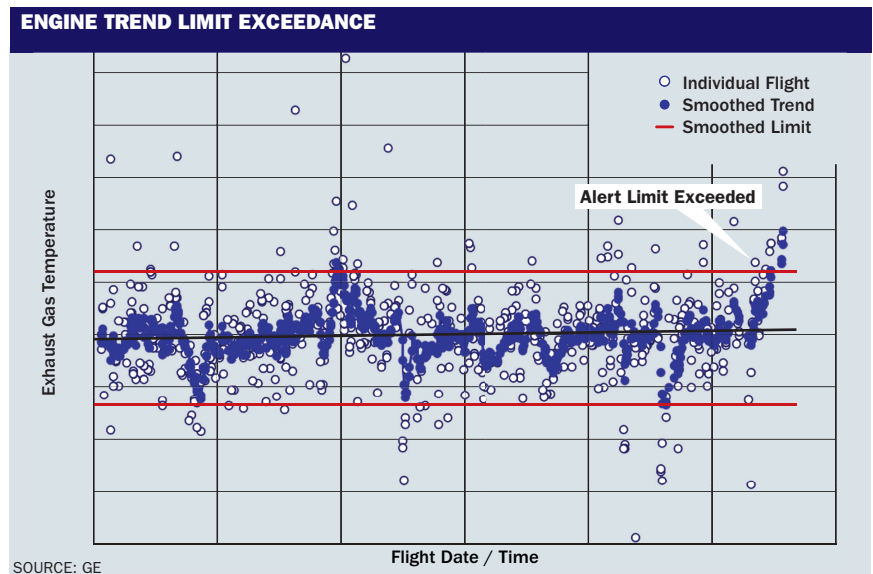
ing the possibility of a false alert. “We can act on something or suppress it, based on if the trend looks real or not,” says Escriche. “If we do detect a real issue, we begin the isolation process” to identify component issues.

**“If we do detect a real issue, we begin the isolation process”**

**LORENZO ESCRICHE**

Manager of advanced technology operations and prognostics health management for GE Aviation

At GE's five company-owned service centres, the trend data is also being used to better plan overhaul visits by estimating the state of the engine before it arrives. Escriche says the predictions in part can help shops better plan for their material needs, potentially trimming turn around time. The process is not currently



SOURCE: GE

» available to third-party overhaul providers.

The next big step for engine diagnostics will soon go live with the GENx-1B and -2B engines, with on-board “reasoning” algorithms that use physics-based models to evaluate performance real-time in addition to comparing values to historical data.

Rather than analysing data associated with thermodynamics of the gas path, as in present remote diagnostic systems, GE is dividing the

engine into six major subsystems, each of which will have simple physics based models for on board monitoring and more comprehensive off-board monitoring. Along with engine starting subsystem, which includes sensors to monitor fuelling, igniter and current and voltage for electric starts, the GENx diagnostic package includes data on the health of the gas path, fuel system, lubrication system, mechanical elements and controls.

### DATA

## PROVIDERS MOVE TO GET AIRLINES CONNECTED

As airlines across the globe move to equip their aircraft with passenger connectivity systems, the discussion is heating up about how to achieve operational gains from these higher-bandwidth pipes.

For maintenance departments, the promise of being able to pull large quantities of information from aircraft in real-time to enhance diagnostics and prognostics is attractive.

“Before, crew may have notified the ground that there was a broken seat on the aircraft via character-specific ACARS,” notes in-flight connectivity consultant Michael Planey. “Now they can provide a more descriptive problem statement in the log and it’s done less expensively as part of a batch of all kinds of other transmissions going to the ground. The maintenance organisation can meet that aircraft with parts or at least be prepared so that a repair or replacement can be accomplished as quickly as possible.”

The problem preventing such efficiencies from being realised on a grand scale, says Michael Denis of professional services firm Aviation Wikinomics, is that there is no connection between condition-based monitoring and supply chain optimisation tools.

“Nobody has connected those tools. Airlines are paying millions, even billions, for modern/technologically advanced aircraft only to dump the information on the floor and do nothing with it,” he says. “The choke point to creating true eco-system collaboration is in

airlines’ maintenance information systems (MIS).”

Denis points out that most airlines and third-party maintenance, repair and overhaul providers are running on 1980s-generation technology. “You can’t connect the aircraft to their MIS and even if you could, these systems couldn’t do anything with the data anyway.”

Addressing this choke point, however, will equate to an improvement in technical dispatch rates, “and improved aircraft availability means higher revenues”, notes Denis.

For airlines that have MROs as part of their operation, the advantages promise to be even greater. “In those instances, the airline is also cashing the check on maintenance labour and maintenance material, and can increase its number of MRO customers,” he says.

But how does the industry address the MIS choke point? “The complexity of this is admittedly staggering,” says Denis. “Everybody has been working on little bits and pieces of the global information net. However, to date, the only guys who have a real financial incentive to do this have been the engine guys because to profitably sell power-by-the-hour agreements requires engine health monitoring bundled into the sale or lease and support package.”

On the OEM side, Boeing has a well-defined business model in its GoldCare programme for 787 customers and the airframer is building the tools to enable eco-system col-

laboration, but it hasn’t sold the vision yet, notes Denis.

Large airline-affiliated MROs have progressed in building decision support networks between suppliers, partners and their customers. But most airlines cannot afford to overhaul their MIS.

This is where aircraft lessors may play an important role, says Denis, as they “have significant influence on these carriers and can spearhead an industry standard collaborative solution”.

Ray Valeika, former Delta Air Lines senior vice-president, technical operations, who currently works as an independent consultant and member of the board at leasing giant AerCap, says: “From a lessor’s standpoint, it is important to have more of a standardised MIS. Then it becomes less costly to transfer an aircraft from one operator to another.”

The manufacturers also have an interest in a more standardised process, says Valeika. “There is some movement on their part to do this with new-design aircraft programmes [such as the Airbus A350, Boeing 787 and Bombardier CSeries], but that doesn’t translate to the thousands of pieces of equipment now operating. So I think it’s going to become a financial play: first on the part of the OEMs to create incentives for more common platforms and also on the part of the leasing companies that own the airplanes, to make them more transferable and thus reduce costs to the operators.” ■

“Today we’re at the mercy of trend points,” says Escriche. “If I can monitor the system real-time, I can better pick up on changes.” He says the onboard monitoring function should be available at entry-into-service for GENx-2B, slated for the late 4Q delivery of the first 747-8 to Cargolux. Along with the ACARS messages, aircraft will also connect to local wireless providers at the gate, sending a variety of additional diagnostics information for trending and storage.

Five years from now, Escriche says to expect new aircraft designs will likely include centralised integrated vehicle health management (IVHM) systems that, in GE’s case, will essentially be scaled-up versions of the GENx engine diagnostics system that monitor aircraft systems like auxiliary power units, brake systems and avionics. “If you take what we have on our engines, the processing could be the same,” he

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says. GE says it is readying such an IVHM system for a 2012 or 2013 entry into service on an as yet unannounced new aircraft.

Another critical subsystem to be diagnosed in the future is flight software, an increasingly common element in all aircraft subsystems. NASA is leading research aimed at the complex issue of how to devise software health management (SHM) systems that can diagnose, predict and potentially mitigate a software failure.

Researchers are currently building several “narrow” prototypes to study how SHM can be applied in a flight control system simulator. “We’re exploring if there’s an adverse event, for instance a hardware sensor goes out, how is it affect the software,” says Ashok Srivastava, principal investigator for the NASA’s Integrated Vehicle Health Management research project. “We’re investigating the opposite as well – if there’s an adverse event in the software, how does it affect the hardware.” ■



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