The past decade has seen a revolution in MRO applications. They have transformed the way airlines and third-party MRO companies operate. It has made these organisations more cost-effective, responsive and flexible. What are the next opportunities to revolutionise the way these software solutions work? Or have the software vendors run out of ideas?

What's next for MRO solution technology?

The significant changes over the past 10 years in computing hardware, network connectivity, processor speed, computing architecture and the underlying database and programming software have created many opportunities for improvement in maintenance, repair and overhaul (MRO). Many organisations went through birthing pains as these new technologies were initially introduced and the kinks were ironed out. Now we have entered a more stable period in MRO technology and the market is becoming more mature. Delivery of standard, off-the-shelf applications over the web that meet the majority of requirements is the norm. Vendors offer similar functionality, so there is a lot of choice and prices are competitive.

What is next?

But where is the next major technology advance coming from? Aerospace is risk-averse and conservative. It does not adopt new ways of doing things without extensive testing and risk reduction, which is understandable given the critical nature of the products and services. The normal path involves piloting new technologies, proving the safety and business cases and then implementing a long adoption cycle, with some airlines and maintenance organisations taking decades to invest in the new way of working. At the end of 2007, there still exist airlines that manage their engineering and maintenance using paper and MS Excel spreadsheets.

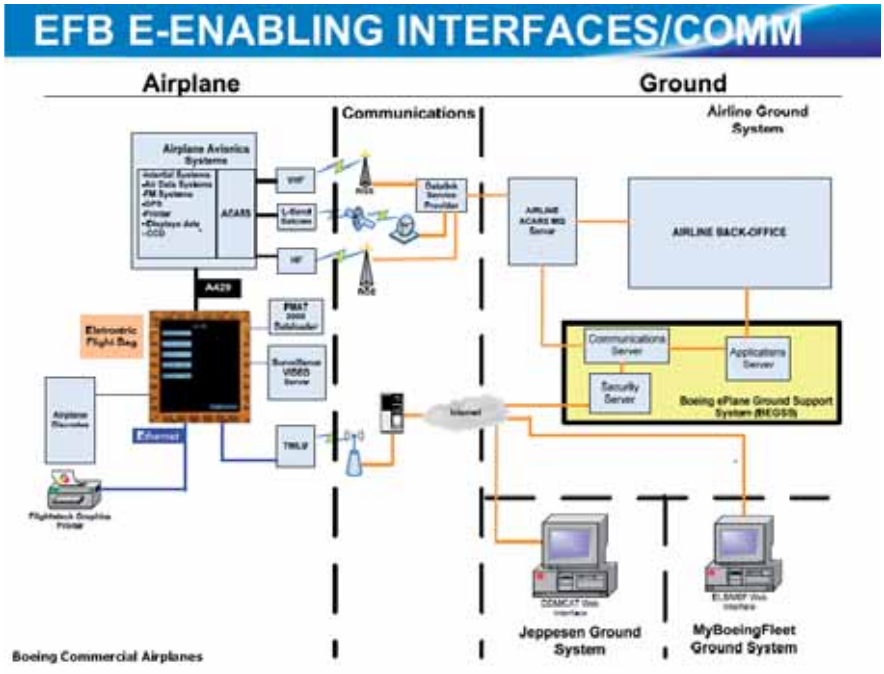
Software vendors themselves also have a role in proposing and driving forward new ideas, but there seems to be some lack of vision and thought leadership. There has been a rush of Java and .NET development to move traditional client-server system architecture onto a full web-based framework *(see MRO software technology strategies, Aircraft Commerce June/July 2007, page 58)*. Most vendors have moved or are moving. Trax, for example, will have its EVO 2.NET product available in early 2008. This is largely, however, an underlying technology and presentation evolution, rather than a change in capability, and is being delivered to the end user. Yes, there are some reductions in running costs and complexities to the IT department and some prettier front-end screens for users, but there is no radical leap forward in capability to support a new way of working in maintenance and supply.

Mobility and less paper

What the new web applications offer are new ways of deploying and working with MRO software applications. There are organisations already taking advantage of handheld computers, tablet personal computers (PCs) and personal digital assistants (PDAs) in the hangar and at the flight line *(see The application of handheld devices in MRO, Aircraft Commerce, October/November 2005, page 48)*. These are more useable with a web application in the mobile environment, with software interfaces re-configured to be displayed on the limited screen sizes, using touch-screens and easier user navigation. Also, clever use of web technology allows the user to work in a disconnected, autonomous way without the need for real-time server connectivity. This is a vital element of any practical application in a heavy maintenance hanger. Of course, the other important piece enabling real-time data capture and work recording, dispensing with paper, is the regulator. While very slow in endorsing and supporting electronic log books and signatures, the regulators are now in a positive frame of mind and the door is open. This clears the way for one new wave of radical change and improvement, supported by MRO software technology. But it will still take many years to fully change working practices and implement new ones. Even by the end of the first decade of the new millennium, therefore, airline mechanics around the world will still be handling paper and using pen and ink to record and register their maintenance actions.

The second step towards a paperless world involves interactive electronic technical publications (IETP). Again these solutions have been around for years, with Jouve, Corena and OpenConnect among the providers. The OEMs, like Airbus and particularly Boeing, with its portable maintenance aid and new maintenance performance toolbox, have come to the market with their own solutions. While some airlines and MRO facilities have succeeded in implementing partial solutions, fully integrated systems are rare. This is one area of change that needs to accelerate to reap the full benefits of investing in MRO technology.

The third area in which technology can provide new opportunities is the electronic technical log (ETL) and electronic flightbag (EFB). This technology has been around for seven or eight years, but it is still immature and developing. Several issues have held it back, including: regulatory approval for removing paper records of faults and corrective actions; the connectivity issues with the aircraft; and the cost of the hardware and infrastructure. As with many technology initiatives connected with the aircraft, the original equipment manufacturers (OEMs) have a large role to play *(see Systems for air-to-ground communications, Aircraft Commerce, August/September 2005, page 42)*. Progress has been slow in getting airlines



The Boeing E-plane ground support system (BEGSS) is a new architecture that integrates airborne and ground elements. ETLs can be passed to MRO software systems on the ground using this architecture to improve speed, accuracy and data richness for the maintenance departments.

to embrace this new interconnected world, particularly to benefit the maintenance community, but there is momentum in this direction now that the European Aviation Safety Agency (EASA) and the Federal Aviation Administration (FAA) support electronic signatures on technical log pages. The MRO software vendors have reacted to this trend by extending their offers to include either in-house ETLs or connectivity to other vendors' offerings.

Ultramain's MRO software suite is used by some of the major airlines worldwide, including Cathay Pacific Airways, Virgin Atlantic Airways, World Airways and Emirates. Like most of the other vendors, they are releasing a new web-based version on a Java EE 5 platform, which is the very latest in Java technology. In addition, Ultramain has a new product, efbFlightLog, which was released at the Farnborough Airshow in 2006. This is a suite of EFB software that allows pilots to capture flight log information in real time and alerts ground-based maintenance systems prior to arrival. This minimises the delays and deferrals that can affect an airline's bottom line. "It is estimated that at least 25% of a pilot's time in the cockpit is spent searching for information and interpreting it, looking for tools and materials, and doing paperwork," comments Kris Toth, marketing manager at Ultramain. "Maintenance crews also lose valuable time waiting for flights to land so that they can access the flight log and begin work. By replacing cumbersome paper flight logs, efbFlightLog boosts the productivity of pilots and maintenance crews. Aviation organisations worldwide are replacing traditional paper-based logs with the more nimble and versatile electronic flight logs, whose immediacy allows crews to report discrepancies as they occur during flight operations. These discrepancies are then quickly relayed to the maintenance team for investigation and resolution prior to the next departure. The result is faster turnaround times that keep the aircraft in the air and off the ground.

"Technical features include support for digital signatures, which integrates with hosted EFB WiFi systems, support for the latest communications protocols including the aircraft communication and reporting system (ACARS) and Iridium, and security of transactions with replication and fail-safe capabilities to ensure data is not lost," says Toth. "Our display colour scheme is designed especially for the cockpit, with no reds, oranges or greens on the display screen, no flashing colour and no glow emitted from the black background. efbFlightLog replaces paper logs, provides additional support for maintenance, transmits logbook information, and integrates with Ultramain MRO software and other maintenance and engineering (M&E) solutions. The system can be configured in a peer-to-peer network, where data is dynamically replicated on all devices providing protection from data loss and system unavailability in the event of a device failure. efbFlightLog is based on state-of-the-art Java EE 5 and web technology, with the main components running in the background, as system services. These services are then accessed via a 'smart' web-based user interface."

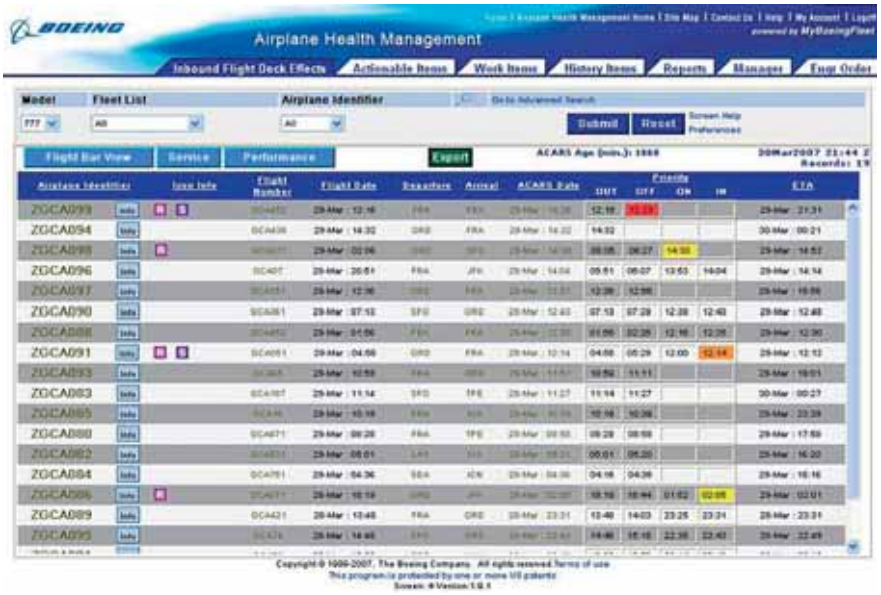
Improvements are in the bag

At the forefront of ETLs and EFBs has been DS&S. One of its major customers, the UK airline MyTravel, operating over 20 aircraft, has a live ETL transferring maintenance and other data. The CoreWing solution requires only a Class 1 EFB *(see Systems for air-to-ground communications, Aircraft Commerce, August/September 2005, page 42)*. "At MyTravel, the data transfer has already reached 96% success at the first attempt to send it and is expected to get to 100% soon," says Nick Godwin, marketing director of civil aviation at DS&S. "Even if the first attempt fails, it keeps trying until it sends successfully. The advantages of electronic data storage over paper for critical documents are clear: higher data capture quality; fewer errors; speed of information transmission; standardisation of reporting to allow easier entry to the MRO system; and trending/analysis. It can take up to two days for paper systems to get data to maintenance staff. Corewing uses COTS tablet PCs and the total savings are around six times the cost of a class 1 EFB. The savings come from reduced administration costs, improved maintenance costs, reduced fuel costs, and significantly better delay and cancellation management, resulting in fewer lost revenue flying hours.

"New and fast-growing airlines are at the forefront of adoption as they seem more able to introduce changes in culture and adapt to the new business processes," says Godwin. "We can implement Corewing in about six months."

The OEMs are getting into this critical area of air-to-ground integration of maintenance and operations data. Boeing has been evolving EFBs for a number of years, and has had several attempts at air-to-ground strategies including the failed Connexion project. Their strategy now is a now on a much less ambitious scale, but it is probably more realistic and pragmatic for airlines to invest in. This involves the Boeing E-plane Ground Support System (BEGSS), which includes communication, application and security servers to enable connectivity on the ground and make integration as easy as possible for MRO systems *(see chart, this page)*. The BEGSS interfaces with an airline's ACARS MQ server and then with its back-office systems, including MRO systems. BEGSS has an interface to My Boeing's fleet management system and to the Jeppesen ground system.

According to Chris Reed, managing director at Trax, this is a major initiative. "The 787 will be the next driver for more



The airplane health management solution extends and enhances the traditional MRO software packages and is a major way forward in improving information management for maintenance departments.

connectivity to MRO software. BEGSS will be the main point of contact for that. We are already working on developing this with Boeing and Virgin Blue to provide the relevant connectivity. This will include ETL, troubleshooting and other elements." Trax markets an EFB solution, but like most of the other MRO vendors which have their own EFBs, Trax has not successfully penetrated the market. Integration with other solution providers like Jeppesen, DS&S and AMT's Flightman is a more likely way forward, taking a best-of-breed approach rather than one-size-fits-all.

In addition to the human data capture of systems like ETLs, the rise of machine-generated data input to MRO systems continues. Boeing's airplane health management (AHM) is a maintenance decision support capability provided via the MyBoeingFleet.com portal. AHM uses real-time airplane data to reduce schedule interruptions and increase maintenance efficiency by providing enhanced fault forwarding, troubleshooting and historical fix information. Advances in data processing, transmission and analysis now make it possible for AHM to deliver valuable information when and where it's needed. AHM integrates the remote collection, monitoring and analysis of aircraft data to determine the status of an aircraft's current and future serviceability. It converts the data into information that can be used to make the operational or fix-or-fly decisions that can make the difference between profit and loss. Exactly which data will result in alerts and notifications to maintenance staff is set by individual operators, who can also determine the particular data and information that each of their employees can view via AHM. That information is prioritised according to its urgency. By customising information packages to fit the role of each user, each user will get the particular information that they actually need. For example, after encountering a flap drive problem en route, a flightcrew called it in. The AHM notification made it possible for the airline's maintenance control organisation to troubleshoot the problem before the aircraft landed. Through real-time uplinks, the airline used AHM to interrogate systems information, identify the problem, and prepare the arrival station for repair. The information made it possible for the airline to avoid a flight diversion, and the subsequent repair delay was reduced from several hours to a few minutes.

Intelligent tagging - RFID

Perhaps the most interesting area of improvement in MRO technology is radio frequency identification (RFID). The technology has taken decades to refine and become cost-effective. The cost of implementation for aviation, the resistance to switching from existing technology, and competing budgetary demands are all causing the slow introduction of RFID by OEMs, airlines and independent MRO providers. Why is it taking so long to introduce RFID into commercial aviation, when it has been around for over a decade?

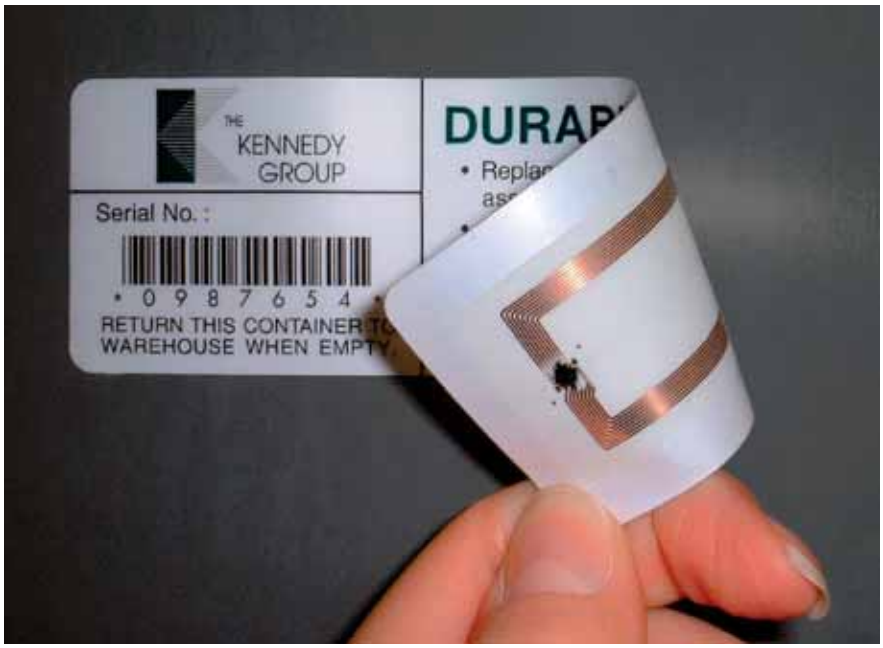
The amount of investment required for aerospace is significant, and no one company wants to pay for a global RFID infrastructure that may become obsolete soon after roll-out. The big benefit of RFID is the speed and lack of human interaction involved in acquiring data about parts and their physical location. Boeing is spearheading RFID use, in particular on the 787. The aircraft manufacturer has commissioned a US company to deliver a 64-kilobit passive RFID tag so that Boeing can identify parts and track their maintenance history, but the chip is said to be a year behind schedule.

Meanwhile, Airbus has concluded a deal with system integrator Odin Technologies to use RFID in 40 sites worldwide. Boeing and Airbus will ultimately be key demonstrators in the use of RFID to track assets, particularly the parts used in aircraft maintenance. RFID tags will ultimately ascertain who's got which part, in which aircraft. Perhaps more importantly, in the age of more outsourced maintenance management and material leasing, RFID will also provide more real-time accurate tracking of who owns which part.

Taking an active role

Clouding the issue is the question of which type of RFID, passive or active, should be used. Active RFID probably has little chance of finding a home with airlines. Although its high per-unit cost will drop over time, carriers are concerned that it could interfere with navigation and communication equipment. Passive tags, which Boeing and Airbus plan to use eventually on critical parts for their 787 and A380 programmes, can receive and temporarily store a small amount of energy.

The cost of changing RFID infrastructure is not insignificant. In 2005, UPS published 'Demystifying RFID in the Supply Chain - an Overview of the Promise and Pitfalls'. Among the drawbacks it identified, tag costs are obviously the major variable cost component for RFID, but what about other related cost components? Software, systems integration, process redesign and organisation impacts will be significant and must be part of the business case as well. In this latter area there seems to be a lack of vision and leadership by the MRO software community. No-one seems to be investing in making RFID technology work effectively to enhance the overall MRO solution. Here the military is ahead of the airlines. The US Department of Defense's (DoD) now-mandated unique identification (UID) programme is the main driver behind integrating RFID into the supply chain. UID mandates that all parts valued at more than $5,000 be marked with a data matrix barcode that is stamped permanently on a part and is useful for tracking and safeguarding against unapproved or bogus parts. But



RFID tags are becoming more cost-effective, flexible and usable in the aviation environment. Providers like SAVI Technologies offer a range of passive and active tags that can store information securely inside the tag, and need no human intervention to scan and capture the data.

UIDs do not have the ability to record the lifecycle of a part as does RFID. The DoD also requires that cases and pallets be marked with RFID tags. In the UK the Ministry of Defence (MoD) has a total asset visibility (TAV) solution in place with SAVI Technologies, and is looking at extending the active RFID technology across its deployed inventory and back into the integrated operational support (IOS) programmes with OEMs like AugustaWestland, Rolls-Royce and BAe.

Airbus is approaching the RFID debate in two stages. Non-flyable applications relate mainly to supply chain and logistics tracking processes, and could include RFID-enabled smart labels on supplier cases, pallets and delivery boxes. Airbus has decided to deploy RFID across such applications, and will probably implement non-flyable processes later this year. Flyable RFID applications, as the name suggests, are those related mainly to in-service operational parts that are subject to regulations. The first application of this could be for time-critical A380 parts. Pilot projects are likely to prove the technology, and the safety case, before going into production.

Done correctly, RFID will remove the human component in much of the supply chain, particularly in parts management and tracking and in maintenance and repair. In the not-too-distant future, RFID-tagged components will allow critical parts to read themselves into the system, essentially becoming mobile nodes in a network. The real key to success is for the OEMs to be involved, initially on the factory floor. Without the OEMs, RFID will remain on the shelf indefinitely.

What do the vendors say?

The view from the MRO software community about the next big wave of innovation is somewhat muted. But perhaps it is just realistic. "RFID will not happen now, at least not until they can get the hardware right," says Reed from TRAX. "That is what we are hearing in all the seminars and shows around the world, and from the OEMs and customers. We are focused on rolling out the EVO.NET version of our application and looking at the BEGSS interface. We are also adding functionality in the area of heavy maintenance and finance."

"The advent of a service-oriented architecture (SOA) in the MRO software industry *(see MRO software technology strategies, Aircraft Commerce October/November 2007, page 58)*, gives software providers the ability to provide customers with custom user interfaces for different users," says Jessica Treadwell, marketing manager at Infospectrum. "These interfaces are accessible from any device be it mobile, desktop computer or shop-floor kiosk. SOA allows custom interfaces to be created without changing the back-end commercial-off-the-shelf (COTS) application. MRO software customers should expect to have a user experience that is specific to their unique business processes without having to create or pay for custom software."

Mxi Technologies is another provider that is technology focused, being one of the first to market with a Java application. "Airlines are demanding a more streamlined process from start to finish," says Evan Butler-Jones, an account manager at Mxi Technologies. "One example is the ability to directly load manufacturer documentation into your maintenance programme management software. Mxi has been working with Boeing specifically to integrate Maintenix with the Boeing Engineering tools, such as Maintenance Performance Toolbox, to enable just such automation.

"Automation of repetitive processes to enable growth without increasing headcount is a priority for many of our customers. To support this goal, Maintenix includes software features such as automated parts reservation, Spec2000 purchasing, and automated check scheduling," says Butler-Jones. "When our customers build a business case for upgrades or expanded implementations, these items come to the forefront of the discussion."

A cloudy outlook

It seems clear that there is no radical technology revolution on the horizon, as far as the software vendors can see. They do not see anything to replicate the change that PCs brought about when they replaced the constrained, limited and user-unfriendly mainframe applications that certainly could not be used in a mobile environment, and which were difficult to interface with anything else. Perhaps there is a lack of imagination and vision as the MRO software market hits a certain plateau phase in its development.

The main areas of technological change over the next few years centre around closer integration with the pilot and the aircraft systems to feed richer maintenance data more quickly to the decision makers on the ground. Whether this is the EFBs and ETLs, or the integration through architecture like Boeing's BEGSS, this still has the power to transform an element of line maintenance and daily operations. The integration with electronic documentation sits alongside this as another area of opportunity ripe for exploitation.

The area of RFID technology is more uncertain. The promise of savings and capability improvement for the supply chain is huge. The military aviation community is forging ahead and may be the pathfinder for this technology. The OEMs will really set the pace by forcing their component suppliers to adopt it. Yet software vendors need to start showing what is possible, so that management can see both the savings to be achieved and the hurdles to be overcome in introducing the technology. AC