

Advances in maintenance & engineering IT systems technology means that more airlines are venturing into paperless maintenance with mobile devices. A review of several systems and case studies of airlines that have implemented and are operating them are made here.

Mobile & paperless maintenance case studies

Maintenance production used to be controlled through the use of paper job cards for routine maintenance tasks. If any non-routine work was required, this had to be hand-written. Task cards would then be annotated or attached to pages of the appropriate technical manuals, such as the aircraft maintenance manual (AMM). Any replacement parts or exploded diagrams to aid defective component identification required would be found in the illustrated parts catalogue (IPC).

Under this system, all the task cards are signed manually by the inspector or mechanic, with an additional identification stamp mandated by the country's regulatory authority. Any findings during the performance of routine cards have to be hand annotated and reference the requisite non-routine cards that must be raised.

The 'dirty fingerprints', the manually signed task cards, are the legal documentation that proves that the maintenance took place. Paper copies for all forms of engineering and maintenance have to be kept for a period determined by the local aviation regulatory authority, or until the maintenance has been superseded through repetition.

Prior to M&E systems

In the early 2000s, an airline operating a fleet of 15 narrowbodies would need to employ a team comprising: one planning manager; three maintenance planners; three or four technical records clerks; a technical librarian; and technical services engineers to assist during manpower shortages.

The technical services engineers would assess any service bulletins (SBs) and airworthiness directives (ADs) before detailing the planners what task cards and documentation to prepare relating to

engineering orders (EOs), and writing task cards for all line and deep maintenance. Scheduled repair orders to change components and items raised in the techlogs would also be addressed.

All technical documentation would be kept up to date by a full-time technical librarian, who would also distribute copies to line stations as appropriate. This is required to maintain aircraft airworthiness currency of the fleet.

The same staff would maintain an archive of maintenance records to demonstrate the aircraft's continued airworthiness, and to allow inspection of documents. It also proves to a lessor or interested purchaser that appropriate maintenance had been performed.

M&E development

Initially airlines were motivated to move into the early M&E systems because of better accountability and faster response to errors. As Al Hegner, director of base maintenance operations at Delta TechOps states: "Before Delta started using Empower MX, if we had a mechanic whose currency had lapsed in an inspection field, all the paperwork for the shifts that he had worked would have had to be manually inspected to see what he had signed for. With EmpowerMX a date range is selected from a search tool, along with the mechanic's name for the inspector field, and every job card that this individual has signed for is retrieved. What could have taken days to find, now takes minutes."

M&E systems developed further into new areas allowing inter-departmental collaboration, such as purchasing, inventory and stock control. Metrics can be gathered for the purpose of continuous improvement and financial control, in addition to manpower control and production planning.

An M&E system initially has to be run in parallel with the paper system for several months to ensure a high degree of accuracy. The correlation proves the system is maintaining the same level of accuracy, and is forecasting maintenance as appropriate. This doubles the workload of the technical records and planning staff, unless temporary staff are brought in to manage and maintain the electronic system. This introduces another level of human error, which has to be considered when introducing a new M&E system.

By far the biggest benefit of a mobile device-capable M&E system for an airline is the ability to monitor 'wrench time'. This is the physical time that the mechanics spend working on the aircraft, instead of ordering or chasing parts, writing up paperwork, chasing inspectors for counter-signatures and creating non-routine work cards.

Wrench time data allows the accurate recording of MH consumed for all the routine cards that were originally called up. It also allows the recording of consumables and common materials that have been ordered to allow more accurate forecasting for the future. For example, if the outer slat has been found to have excessive play in its bearing in five of the last six aircraft of a certain age, and the part is a low cost item, it can be pre-ordered and held in stores. This means that pre-loaded spares reduce the possibility of delays in the check.

Mobile revolution

Early M&E systems scan ID cards or swipe them through terminals to sign off task cards and similar items. Task cards are completed and scanned, either by barcode, magnetic strip or closed out on remote terminals that are hardwired to points in the hangar or the back office. The time spent walking between the



aircraft and the M&E terminals, or out on the line between the aircraft and office, can require a trip in an airport vehicle, ranging from a few minutes to up to half an hour. This is all lost time that could be spent working on another aircraft. New generation M&E systems are forging ahead here, allowing mechanics to spend more time working on aircraft, by using mobile devices connected to wireless data networks through WiFi or high-speed cellular mobile access via GSM networks. This is achieved with mobile devices that can fully utilise the latest HSDA+ (High Speed Data Access Plus) and 4G (4th generation) mobile data.

The M&E system on the computer terminals, and the handheld devices, is likely to be run in conjunction with a document or content management system (CMS). This will associate task cards with the relevant pages of technical manuals, such as the AMM and IPC. These used to be printed, but now can be loaded onto handheld devices. A problem arises where the airline or operator is not running fully digitally. It is all well and good to have the main hubs and the heavy maintenance facilities running digitally, but if the remote line stations are not working with the same level of data connectivity then paper copies of work cards are still created. These have to be returned to the central technical records departments to be entered into the M&E system, which duplicates work.

Hardware manufacturers

Panasonic

Panasonic's Tough range of ruggedised laptops and tablets has been a

staple choice for many airlines and operators, with the Toughbook used in airline maintenance environments for quite some time now. Typically the use of Toughbooks is in the form of remote access to the AMM or similar. The Toughbook is used widely in hangar and line maintenance environments, and they make a viable alternative to paper task cards. The main drawback with the use of Toughbooks is the need for a 3G (third Generation) GSM or a better WiFi wireless network, to allow access to relevant technical documentation, unless this is stored locally on the hard drive of the Toughbook. This then raises issues, however, about ensuring concurrency with the latest revisions of the maintenance manuals, or as issued by the appropriate OEM.

The new generation of Toughpads has allowed task cards to be almost entirely digitally rendered in their original format. This is with the use of embedded hyperlinks to open links to relevant AMM or IPC data, and further links to areas of the M&E system, such as parts request systems, as necessary.

These new devices are standard tablets that have then been entirely redesigned for use in heavy engineering environments. Many have achieved MIL-STD (Military Standard) accreditations and far outstrip the previous generations of Toughbooks for processing power, internal storage and embedded hardware. The feature of an embedded camera is an example. This is used for taking pictures of defects that require supervisor inspection. They can be emailed to the necessary individuals or attached to task cards to record deterioration. This can then be reviewed easily. The Toughbook and ToughPad are premium products that command a premium price tag.

Swiss Aviation Software's AMOS system can be used together with iPad or Panasonic Toughpad tablet devices. The user logs in through a Citrix programme. The user can access AMOS remotely if they can establish connectivity, as well as accessing areas such as Airbus World and AirN@v.

Apple Inc

The Apple devices have been used for some time, but there is still very little control over the iOS (previously iPhone OS). This is a mobile operating system developed by Apple Inc, and distributed exclusively for Apple hardware.

The lack of any real control over the hardware itself is down to the four layer approach that iOS runs from. These are the Core OS (operating system) layer, the Core Services layer, the Media layer, and the Cocoa Touch layer.

Any M&E system that is placed onto an iOS device will not run at the Core OS level, and will only embed as far as the core services level. This means that unless the M&E provider has written its own OS to run the device, any software updates from Apple for the iOS could potentially interfere with any additional security that has been placed on the device. A hardware reset simply initiated by holding buttons in a certain configuration would render the device compromised. Ruggedised casings help protect the iPad, but the cost versus risk analysis in comparison to the latest Toughpads from Panasonic puts Apple far in the lead here. This is at an almost four-to-one cost ratio, as long as the relevant steps are taken to ensure the devices cannot be compromised from a security standpoint.

Dell

Dell is late to the tablet party in terms of use by M&E and digital techlog providers. It has recently been showing more promise though. Dell's XFR range of ruggedised laptops put it in the same field as Panasonic. Dell is nearly \$1,000 more expensive for little additional functionality, however.

Dell's tablet option was to fit its ruggedised laptop with a capacitive touch screen, and an extremely strong central hinge mechanism that allows the laptop to rotate through 180 degrees and fold flat on top, locking into place. To many, this was seen as enough, but it is hard to justify when it is five times the price of an iPad or android device with the same functionality.

More recently with the advent of Windows 8, Dell has stepped up in the tablet market. Third-party companies, such as Targus with its SafePort Rugged

Max Pro case, can give the Dell tablets similar levels of protection to the Toughpads of Panasonic. This is a suitable platform to lock down with EFB (electronic flight bag) and ETL (electronic tech log) developers Conduce, which is writing software and programmes specifically for this format. Locked-down versions of the operating system can allow access to browser-based M&E systems, while ensuring the security and integrity of the system from unauthorised access or use.

Providers

MXi

MXi is one of the larger pure-play MRO software providers, with over 250 employees. Founded in 1996, the company is based in Ottawa, Canada. It also has offices in Washington and Seattle, USA; Amsterdam, Netherlands; and Sydney, Australia.

More than 70% of MXi's business involves airline and third-party commercial MRO. The company works with implementation partners worldwide including Pythian, Envision, TATA Consulting, Hexaware and Milcon Gulf Group. MXi continues to make progress, having signed the 787 Dreamliner GOLDCare deal with Boeing. Like many of the larger MRO software companies, MXi's product runs on Java technology.

The Maintenix modules include: maintenance programme management; AD/SB management; configuration management; records management; diagnostics & repair modelling; long-range planning; asset maintenance planning; maintenance control; line maintenance; maintenance operations; production planning & control; hangar maintenance; engineering support; shop scheduling & repair routing; shop production control; shop maintenance execution; material planning; material procurement; warehouse management; warranty management; material receipt; demand management; tool control & ground support equipment (GSE); compliance reporting; quality assurance; reliability analysis; maintenance cost tracking; financial reporting; and human resources (HR).

The Maintenix product has the capability to seamlessly integrate with EFBs, the Airbus Airman product, and Boeing's AHM. MXi is a clever choice in the marketplace, since it does not require specific hardware to run, as long as the browser being used supports Java and other standard browser embedded software. MXi's offering can literally be viewed anywhere there is a mobile data connection.

MXi uses a wide variety of digital

sign-off choices, from biometric through to pin entries. As James Elliot, product marketing manager at MXi comments: "We can accommodate almost all requirements from operators. Typically the best way to integrate digital sign-off is to digitise whatever an airline has in paper format. Signatures can be digitised and embedded onto printed hardcopies, and Mxi can also incorporate biometrics if required."

TRAX

Trax recently added capability to support all electronic signatures in its production module. The manpower planning system has undergone a major revision for this version.

The new web-based version of Trax (which is supported in-line with the traditional version) and a revised GUI for the existing product have been released.

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Mobile access and PDA support have been added for many functions within Trax, particularly in the warehouse management area.

Multi-company capability is available for those customers that use Trax Enterprise. New functions include long-range planning and e-enabled aircraft capabilities. Biometric security (fingerprint recognition) and smart cards are available throughout the Trax system. Lightweight directory access protocol (LDAP) capability and further Windows Networking security has been added. RFID has been added for inventory functions, and will continue to be deployed through the system in the future.

Available modules in Trax include: material management; engineering; planning; production; maintenance control; component maintenance; quality control; human resources; financial management; and interfaces to numerous outside systems.

An Air Canada avionics mechanic, who uses Trax, gave the following information to *Aircraft Commerce*: “There were two aircraft being worked on in the midnight shift. My partner and I were taking care of the second aircraft, which had one of its radio altimeter systems giving erratic indications to the flight crew. This information was taken from the techlog and the job card was raised to investigate and rectify.

“The transceiver had been previously replaced, which did not fix the problem. Before removing the antennas, we searched the maintenance manuals through the Trax system to find the procedures to address the problem. Typically, if this had been a scheduled task, the AMM data would have been linked within the task card. We also put

in a requisition for gaskets for the antennas. At 07:30am our lead tells us that the other aircraft is ready for flight, and we have to bring it to the ramp on gate for departure.

“When we get back to the hangar, we continue work on the antenna on the first aircraft. We eventually discover the coaxial connector is full of fluid, and that corrosion has started to settle in, shorting the circuit, which is the most likely cause of the erratic signal. We move back to the office to order an antenna and a cable.

“While we are waiting for the parts to arrive, we carry out other minor work as required. When parts for the radio altimeter arrive and we install them. Final system checks are carried out, before we digitally sign off the e-task cards using pin codes. This informs our lead of the situation automatically. He then calls us to let us know that the plane will be used on an 18:00 hrs departure to Miami, and assigns us new tasks based on our skills and qualifications.”

SWISS AS

Swiss AviationSoftware is a 100% subsidiary of Swiss International Air Lines Ltd with its headquarters in Basel/Switzerland. The company was founded in 2004, but the history of its product AMOS goes back to 1989 when the foundations for the software solution had been laid.

In 1992, the system was sold for the first time and sales have increased in double digits ever since. With the spin-off from its mother company, the team has been given the opportunity to fully concentrate on its core business to successfully develop, market and sell the one product called ‘AMOS’.

Users of EmpowerMX's FleetCycle system, that is used in combination with internet and web-browser technology, are able to use a tablet device at any location to track detailed task data at maintenance stations in real-time.

AMOS is a comprehensive, fully-integrated software package that manages the maintenance, engineering and logistics requirements of modern airlines and MRO providers.

More than 110 customers globally utilise AMOS. This makes AMOS the industry-leading MRO software in Europe, and one of the best-selling solutions worldwide.

AMOS users range from pure operators, major charter, regional and low-cost carriers up to large airline groups and MRO providers. A solid customer base actively contributes to the continuous development of the product, and a valuable external network and comprehensive knowledge database could be established through close collaboration with the customers.

AMOS is completely written in JAVA, fully web-enabled and hardware-independent. In addition, Swiss-AS offers its customers a full package of services ranging from initial requirement studies, process analysis, through onsite-support, user training, data migration, audits to system customisations, interface programming, and 24-hour/7 days a week support.

easyJet uses AMOS for nearly every aspect of its operation. *Aircraft Commerce* spoke with line and base maintenance mechanics who work for easyjet. “We have been using AMOS for about four years. We heard a fair amount about the system before, and had some training. It was a big shock to go from the old Albislex ERP (enterprise resource program) system to AMOS, however.

“The sheer level of additional functionality was astounding, and being able to just quickly select routine items such as oil uplift and tyre pressures from either simple dropdown menus or from pre-laid out forms was fantastic. Signing-off task cards and other additional work in the system is simple. This works with just dropdown boxes and password systems linked to your user IDs. The system works well in the hangar or line office, working though Dell PCs.

“You have to log in though a Citrix programme neighbourhood. As far as we are aware this is an easyJet requirement, not mandated by AMOS, since there are lots of other easyJet applications on there. These include Aerdata's techlog viewer, and MS office applications.

“What has been exciting is that



recently the aircraft have received Panasonic Toughpads in the cockpit. These work great. If we can get connectivity, we use the Toughpads to log into AMOS, and other areas such as Airbus World and AirN@v. Obviously this is a massive time saving, if out on the line rather than having to walk or drive back into the office. In addition, easyJet is trying a laptop in the back of a van with a printer and a wireless dongle on 3G. To be honest it is temperamental. We are not sure if it is the van acting like a Faraday cage, or if we just have poor mobile data signals where we are. The point is that if I have to come off the aircraft to use the van, I would rather drive back and get on a proper PC in the office, rather than potentially struggle. It does work, but it is easier to use the cockpit. If that is not working then you are back to paper and printers anyway.

“AMOS works phenomenally well, but if it stops working then you are stuck. The connectivity problems may be the tablet you are working from or the van. If a call to the office confirms it is the whole system, then you lose valuable time, and in this case we are far from paperless.”

EmpowerMX

The EmpowerMX's FleetCycle® suite of software applications, in combination with advanced internet and web-browser technology, allows airline maintenance professionals to use any internet-enabled personal computer/mobile device at any location to track detailed task data from maintenance stations in real-time.

Intelligence gathered with the system provides an accurate, timely basis for improvements in the efficiency and integrity of maintenance processes and

the forecasted availability of aircraft.

EmpowerMX's vision is to provide solutions addressing all aspects of aircraft maintenance and engineering operations. The maintenance intelligence generated by these solutions should allow its customers to secure an advantage in the highly competitive industry.

Initially, EmpowerMX was focused on heavy maintenance execution. Today, the FleetCycle Execution Suite - Production Manager (FCPM) product, hangar floor/back-office PC workstations, wireless handheld 'smart' devices and advanced internet technologies are deployed at every major airline in North America as their primary maintenance execution solution.

Customers calculate that labour efficiency gains of 10-30%, improved materials management, efficient check flows and significantly lower turnaround times have all been achieved with implementation of this NextGen IT product. This limits its market somewhat to larger airlines that have yet to invest in a fully integrated MRO solution, and just want to update and modernise their maintenance operation.

EmpowerMX modules include: production manager; line manager; maintenance program manager; maintenance intelligence; and planning manager. The product is Java-based and the company's customers include large airlines like US Airways, American Airlines and Delta Airlines. It has seven live customers, and offers the solution as an ASP option. The company has been in business for 11 years and is based in the USA.

Al Hegner, director of base maintenance operations at Delta Tech Ops, is responsible for over 1,550 maintenance mechanics and engineers

EmpowerMX allows each mechanic to access their assigned task cards. Each task card can have all the necessary documentation references linked. A mechanic can also request parts, as well as contact supervisors.

that work on Delta's aircraft, as well as customer fleets. Hegner explains the need to maximise what Delta has coined as 'wrench time'. "We found that prior to using EmpowerMX we had excellent metrics and we were up there among the other MRO providers," says Hegner. "But we wanted to become the industry standard and take our MRO service to the next level. We selected EmpowerMX in 2012 to help achieve this. We took our metrics and looked at how we were using labour, how we were completing major checks, how the work was flowing through the check, and that we were meeting the correct milestones as appropriate. Most importantly we needed to be able to control this remotely. We wanted to be able to access the system from anywhere on the planet.

"This is where EmpowerMX was able to really come in and deliver for Delta," continues Hegner. "The system is paperless. If you now walk into a paperwork booth it does not look like a newsstand. All the task cards are on the system, which means we have reduced human factor and paperwork errors. Previously, we have had problems of task cards going missing from check packs and signatures being missed. Now the system allows us to track each and every task. If there are any missing signatures or something similar then you cannot physically close down the task. This really helps us reduce non-compliance errors.

"An example is changing an engine. If you are walking up to the aircraft, tablet in hand, we can now sign off every block on each task card on the tablet," continues Hegner. "You can directly link the necessary AMM references, which means the technician with the tablet does not need to leave the engine. Also, he does not need to go to the booth on the floor to access the AMM. Instead, he can request, via the tablet, the technical lead to come and assist him. He can also order parts right there at the tablet.

"In the hangar environment there is a green line around an aircraft," continues Hegner. "This designates the area where anyone who enters the area has to wear personal protective equipment (PPE), safety glasses, and hardened foot protection. Because the tablet has connectivity, once a mechanic is signed onto a task in this area, the only reason why he or she should need to leave is for

Ultramain's Mobile Mechanic software provides mobile maintenance capability on tablets that include the iPad, iPhone, Galaxy tab and Galaxy Note. The mobile suite is compatible with iOS, Android and Windows8 devices that are capable of WiFo or cellular connectivity. Digital signatures can be made via the tablet.

a comfort break.

"The efficiency improvements by keeping the mechanics on the aircraft are clear," adds Hegner. "Previously, on the floor we were able to achieve six hours on-tools recorded work in a shift. Now we are able to track eight hours per day of actual tools on-work. The benefit we were able to see straight away is the sheer visibility of what is happening on the shop floor. You can see exactly where you are in a check. Two main benefits are that we can see exactly how the shop floor is performing down to individual members of a team, and more importantly we can see where previously we were not performing and make changes as necessary.

"Manpower planning has also been revolutionised," continues Hegner. "Previously, we would be working solely to what was coming up in a few weeks. Now we can plan our manpower 50 days in advance, and right out to 180 days in advance based on competencies and qualifications. All this contributes to being able to reduce our turn times on checks. Task cards are signed off using multiple pin codes, but when you request an inspector or an over signature you no longer have to ask the inspector to come down and check the paperwork. Instead, he is automatically directed to the work that the mechanic has done, and he is fully apprised of the situation before he comes out and sees the physical work that has been carried out. A few clicks later and the inspector has signed off, and is on his way to the next job. Moreover, the mechanic has not had to leave the aircraft, and can get on with the next task without delay. Through making these improvements, we have been able to increase our time on task from six hours to an average of eight hours per man-hour day. This yields improvements, in all respects, of more than 20%."

Ultramain Systems

Ultramain Systems Inc offers its platform-independent mobility tools for aircraft maintenance and inventory operators.

Ultramain's Mobile Mechanic software product provides fleet operators and MROs with mobile capabilities on numerous devices. These include the iPad, iPad mini, iPhone, Galaxy Tab, and Galaxy Note. The mobile suite is compatible with iOS, Android and

ULTRAMAIN		Task ID:	777F-38-010-00-01/200
WO:	4924245	Zone:	
Asset:	N100SU	Phase:	10-Install
Shop:	HANGAR	Craft:	AF
Pkg ID:	N100SU-A-12-JUN-03	Skill:	
		Issue Date:	02/28/2014
		MR:	777F-A
		MR Rev:	11
		Rev Date:	01/14/2014
Pkg Title:		FAN BOOSTER COMPRESSOR MODULE ASSEMBLY INSTALL	
Task Title: FAN BOOSTER COMPRESSOR MODULE ASSEMBLY INSTALL			
Instructions	Mech	Insp	Ind
SETUP AND PREP INSPECTION NOTE: HIGH CORROSION AREA Show task 72-00-01-420-001	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INSTALL THE HPT MODULE. REFER TO TASK 72-00-00-420-001 (72-00-00, INSTALLATION 001, VERSION ALL) Show task 72-00-01-420-001	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
INSTALL THE CORE MODULE ASSY (59-240, 72-00-00). REFER TO TASK 72-00-02-420-001 (72-00-02, INSTALLATION 001, VERSION ALL) Show task 72-00-01-420-002	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
END OF TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Windows8 devices capable of wireless operations via WiFi, cellular, or Bluetooth.

Ultramain v9 is completely browser-orientated from a desktop point of view, working from JAVA EE. In addition, the system is available in APP format for the various mobile platforms. The security and access protocols are linked to the user profile so that only licensed engineers can sign-off aircraft.

The system is completely independent, favouring no particular OS. This allows greater freedom of choice for operators. The devices do not even have to be operator-owned. A Mechanic can access the APP from his own personal device, since the security is held within the browser through the various logon options.

According to John Stone, vice president of product management at Ultramain Systems, "Delivering easy-to-use mobile functionality is an important part of Ultramain Systems' product strategy. We have already proven that eliminating the paper aircraft technical log is possible with our successful efbTechLogs™ software. USI has extended the paperless M&E operations to mobile devices on the ground.

"Paperless operation using mobile devices is possible in complex aircraft maintenance environments with the availability of Mobile Mechanic," continues Stone. One of the largest challenges USI faced when implementing the digital signature part of the programme was the need to prevent any unintentional changes to the digital sign-off records. USI achieved this by storing a 'digital dirty fingerprint' record of the

sign-off, as well as not only recording any alterations, but also notifying the relevant quality assurance departments within the operator.

Signatures can be made via a tablet and can be made off-line should connectivity be lost. Once connectivity is re-established the system automatically updates the operator's server with any sign-off changes. This is also true for tits EFB software. If the EFB does not have connectivity, A USB stick can be inserted into the EFB and a digital copy of the sign-off can be downloaded and then uploaded to a hard terminal in the line office.

"This is a far better system than relying on a thermal printer or the like, since this defeats the object of being paperless," says Stone.

"Ultramain's Mobile Mechanic provides mechanics with the ability to perform maintenance in a mobile environment. Traditionally these were only available from fixed, hard-to-access M&E systems. Mobile Mechanic makes them available from virtually anywhere without the overhead, costs, and required use of paper typically associated with such systems."

Stone points out that USI has extensive experience developing paperless M&E software said, "USI is one of the only software providers with aircraft M&E and MRO customers running paperlessly on both the line maintenance and base maintenance side of their business."

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