Several technologies have emerged and been adapted to assist the many manual steps in the traditional line maintenance process. The full process is completed with the use of an electronic technical log (ETL) or electronic logbook (ELB). The practical use of these systems by airlines is examined.

The digitisation of line maintenance

The manual and paper-based system used by almost all airlines to manage their aircraft's technical defects and faults arising during operation, involves reporting via a handwritten paper technical log. This archaic, inefficient and expensive system has changed little in the industry's seven or eight decades. A few airlines have managed to fully evolve it into a fully digitized process, and are reaping multiple benefits, all of which are delivering cost savings.

This digitisation involves the need to record defects and faults shortly after they occur, describe them accurately, gain any health monitoring or automatically-produced detection data, and transmit it from the aircraft to the ground as soon as possible. The timely transmission of data from the aircraft to the airline's maintenance operations control (MOC), maintenance control centre (MCC), and maintenance and engineering (M&E) department requires the aircraft to have air-to-ground connectivity systems. The initial logging of faults and defects requires the replacement of the traditional handwritten paper techlog with an electronic techlog (ETL) or electronic logbook (ELB). Using an ETL means that it is now possible to seamlessly transfer data from the moment a defect arises all the way to its rectification, and to archive a record of this electronically.

Implementing and using an ETL/ELB system, interfacing with flightdeck connectivity systems, developing a process for diagnosing faults, preparing their rectification, and executing maintenance so that the whole system is fully digitized and paperless is examined here. The operation of a digitised line maintenance system is illustrated by looking at several airlines that have implemented such systems in recent years, and have realised many operational benefits and cost savings.

Traditional line maintenance

Aircraft are constantly developing technical faults during operation. In traditional line maintenance, these are recorded manually on handwritten tech logs, usually by flightcrew, although less complex defects arising in the passenger cabin can be recorded by cabin crew on a cabin log. These cabin logs can later be added to and completed by the flightcrew.

There are four or five categories of technical defects observed and recorded by the flightcrew, cabin crew, and line mechanics and technicians.

The first of these are faults with aircraft systems and rotable and repairable components. Since the introduction of the 757/767 and A310/A300-600 in the early 1980s, aircraft systems and their related components have been fitted with built-in test equipment (BITE) sensors to detect malfunctions. Such issues are transmitted to the aircraft's central maintenance computer (CMC), which generates and sends a fault code to the multifunction control display unit (MCDU) on the flightdeck. This is also printed on a post-flight report (PFP), to alert the flightcrew.

An example can be a fuel pump delivering insufficient fuel pressure. This is detected by BITE sensors, and a CMC fault code is generated. Fault code formats vary on different aircraft types. Some are six or eight digits, while others are alphanumeric.

The fault code can be transmitted to the airline's MCC or MOC to start diagnosis and action, but can also be recorded manually by the flightcrew on the tech log. The first standard system for in-flight transmission of fault codes is the aircraft crew and reporting system (ACARS), which can send messages and CMC fault codes via very high frequency (VHF) or high frequency (HF) radio when operating overland, or via satellite communication (Satcom) systems when operating over water or deserts. Higher bandwidth satcom systems have been developed partly for this purpose.

Transmission while in the air gives MCC/MOC and line mechanics time to diagnose the fault code themselves, by looking up the fault codes in the printed troubleshooting manual (TSM) or fault isolation manual (FIM).

Software to look up fault codes was introduced by Airbus and Boeing. Airbus' AIRMAN system compares the received fault code to its database. AIRMAN has evolved into its current Skywise product. Boeing offers its AHM product.

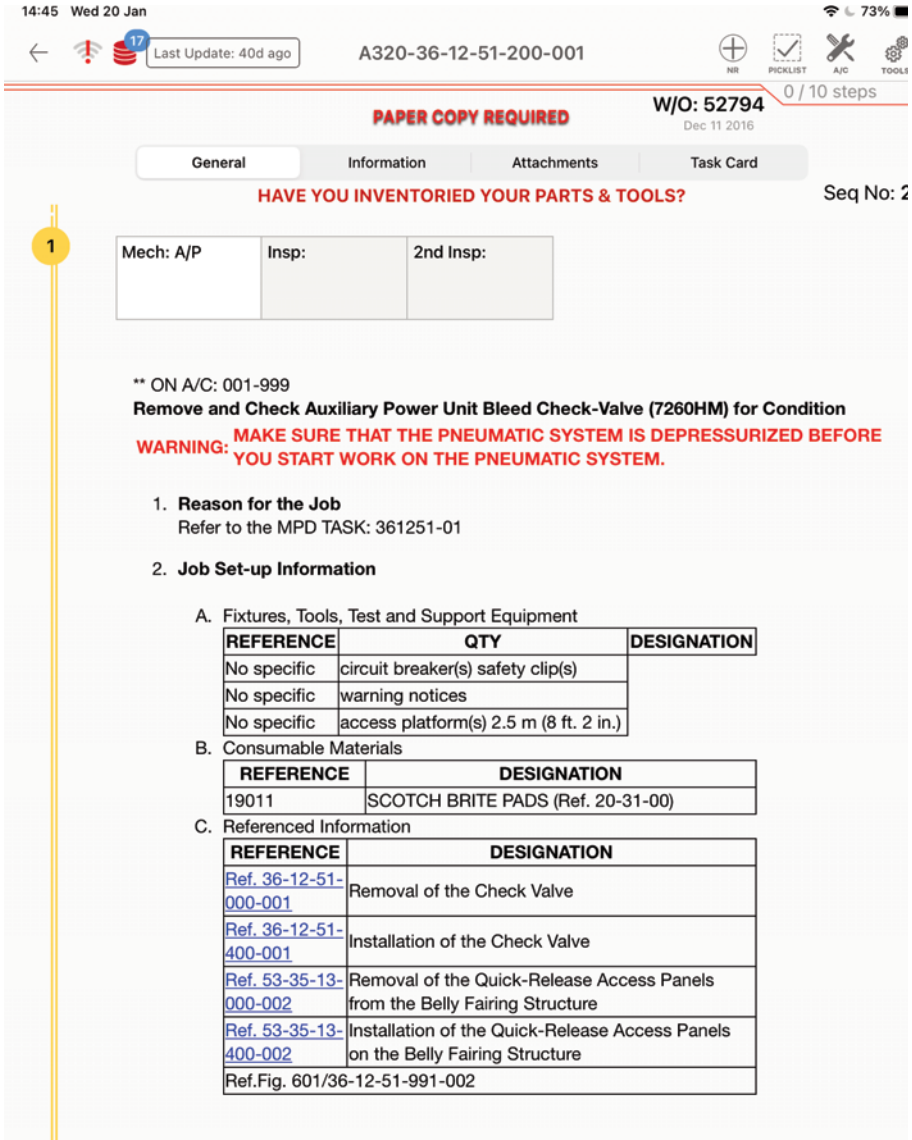
The MCC and MOC department will be alerted to the fault while the aircraft is still in the air if the necessary connectivity systems are installed. If this is the case, the MCC/MOC will first need to determine in the minimum equipment list (MEL) if the defect is a 'Go' or 'No-go' issue.

The MEL is a flight operations document, and is kept on the flightdeck and in the MCC/MOC. Flightcrew use the MEL to determine how a CMC fault code may restrict the operation of the aircraft.

In the case of most aircraft types the second and third fault categories are regarded as a single category. The flightcrew are alerted to these through messages on the electronic centralised aircraft monitor (ECAM) or engine indicating and crew alerting system (EICAS) display screens on the flightdeck.

In the case of a few modern types, such as the A350, the aircraft's on-board maintenance system (OMS) divides them into two categories.

On the A350, the second category of defects and faults comprises those on aircraft systems that are classed as dispatch issues. These affect aircraft systems and components, but do not generate CMC fault codes. On modern aircraft types the



14:45 Wed 20 Jan 73%

17 Last Update: 40d ago A320-36-12-51-200-001 NR PICKLIST A/C TOOLS

0 / 10 steps

PAPER COPY REQUIRED

W/O: 52794
Dec 11 2016

General | Information | Attachments | Task Card

HAVE YOU INVENTORIED YOUR PARTS & TOOLS?

Seq No: 2

1

Mech: A/P	Insp:	2nd Insp:

** ON A/C: 001-999

Remove and Check Auxiliary Power Unit Bleed Check-Valve (7260HM) for Condition

WARNING: MAKE SURE THAT THE PNEUMATIC SYSTEM IS DEPRESSURIZED BEFORE YOU START WORK ON THE PNEUMATIC SYSTEM.

1. **Reason for the Job**
   Refer to the MPD TASK: 361251-01

2. **Job Set-up Information**

A. Fixtures, Tools, Test and Support Equipment

REFERENCE	QTY	DESIGNATION
No specific	circuit breaker(s) safety clip(s)	
No specific	warning notices	
No specific	access platform(s) 2.5 m (8 ft. 2 in.)	

B. Consumable Materials

REFERENCE	DESIGNATION
19011	SCOTCH BRITE PADS (Ref. 20-31-00)

C. Referenced Information

REFERENCE	DESIGNATION
Ref. 36-12-51-000-001	Removal of the Check Valve
Ref. 36-12-51-400-001	Installation of the Check Valve
Ref. 53-35-13-000-002	Removal of the Quick-Release Access Panels from the Belly Fairing Structure
Ref. 53-35-13-400-002	Installation of the Quick-Release Access Panels on the Belly Fairing Structure
Ref.Fig. 601/36-12-51-991-002	

The task control app provided by Trax. This is used by mechanics to perform maintenance from electronic task cards.

flightcrew are notified of these types of defects through messages read on the ECAM and EICAS screens.

These defects are notified by basic messages, such as 'Autopilot off'. This gets manually entered into a paper tech log, and can also be transmitted to the ground.

The third category of defects is also reported via messages on the ECAM and EICAS screens on Airbus and Boeing aircraft. An example of this type of defect is 'Autoflight FMC fault'.

The fourth and fifth categories of defects are those that cannot be detected by sensors in the aircraft's components and systems, and so do not generate some sort of fault code or alert message. These are observed faults, or reports of some type of physical damage. Observed defects and faults have to be manually recorded by crew members in a technical log.

The fourth category of defects is those observed by the flightcrew, and recorded in the pilots' techlog and pilot reports. These include broken items, which only require simple fixes, and observations where items such as flight controls do not respond properly. Other examples are tyre bursts or damage, lightning strikes, and airframe damage due to foreign objects. These can include a large number of 'No-go' faults.

The fifth category of defects comprises observed faults in the passenger or cargo cabin, and are reported by the relevant crew members. These will mainly include items that affect the comfort of passengers, and can include items that are classed as 'No-go' faults. Examples include inoperable exit doors; or toilets, since a minimum number are required for the aircraft to be operable; broken or unserviceable life jackets; and inoperable cabin floor lights. They can be grouped by category: doors; seats; lighting; emergency equipment; lavatories; galleys; and flooring.

Although 'Go defects', such as dirty seat covers or inoperable coffee machines, do not require immediate rectification, they can affect an airline's goodwill.

Fault management

With a paper-based techlog system, the MCC/MOC and line stations only become aware of most defects when the line maintenance technician reads the techlog on visiting the flightdeck after landing.

A main issue with this system for reporting defects is that each has to be diagnosed with respect to its MEL status, so whether it is a 'Go' or a 'No-go' type of defect. All defects therefore have to be diagnosed to an initial level relatively quickly to avoid disruptions to the airline's and aircraft's schedule.

If the defect is classed as a 'Go' issue, it can be deferred. The MEL will also dictate for how long, in terms of number of flights or days, it can be deferred. If it is a 'No-go' item then it has to be corrected and fixed after the aircraft lands and before it flies again. This could result in an aircraft-on-ground (AOG) situation, causing lengthy and expensive delays.

The aircraft may be heading towards an outstation, several thousand miles from homebase, where line maintenance is sub-contracted to a third party. The fault must therefore be diagnosed as quickly as possible, and if it is found to be a 'No-go' item then the nature of the fault must be transmitted to the outstation as soon as possible, so that a third-party provider can start making the necessary preparations to address it.

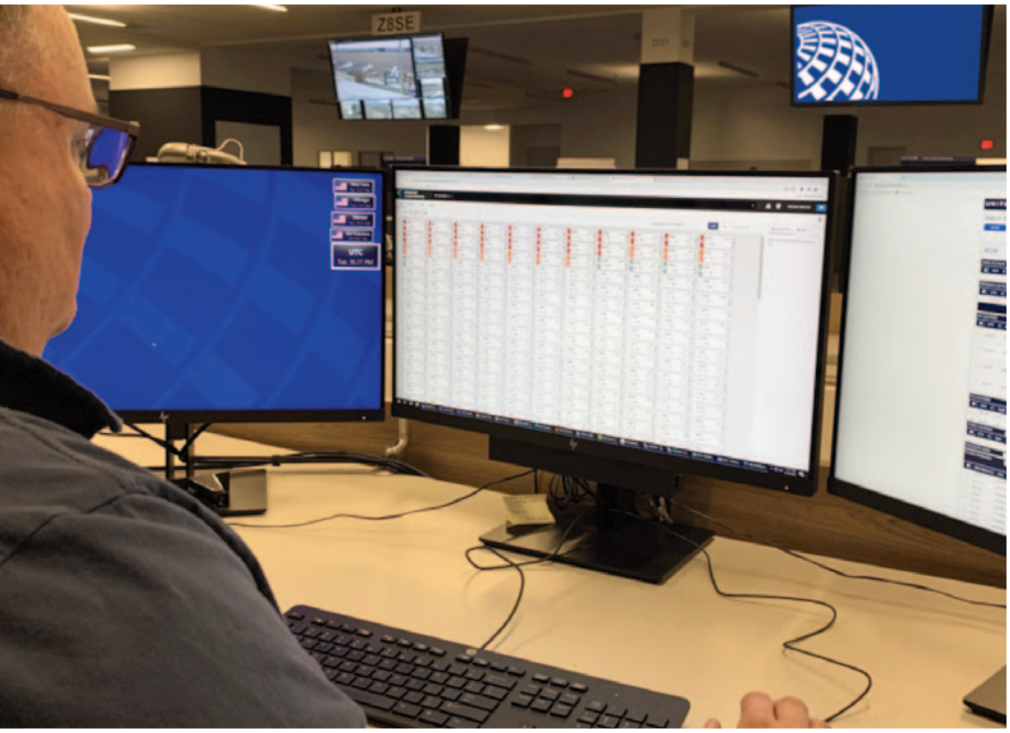
Time can be saved, when using a traditional paper system, if information about the fault is transmitted directly to the line station at the same time as being sent to the airline's MCC/MOC. It is essential to react to a notification of a CMC-type fault as soon as possible, because it is this category that accounts for most 'No-go' faults.

If the defect is not transmitted in-flight, then the MCC/MOC and line maintenance station are only made aware of it after the aircraft has landed, and the line mechanic visits the flightdeck and is informed by the flightcrew and the techlog.

The line maintenance mechanic can start to investigate the defect by using their own set of technical manuals. The lack of flightdeck transmission and connectivity systems therefore delays the process of diagnosing the fault and preparing for its rectification. This will lengthen AOG events and associated delays.

Time can be saved with the in-flight transmission of the CMC fault codes, but this does not happen with four of the fault categories. Some defects clearly have to be investigated by a line mechanic, and it is often the case that they find nothing when they investigate 'No-go' faults reported on the tech log.

Once the line mechanic has fixed 'No-go' faults, deferred 'Go' faults, and



Many airlines use fleet status boards on flight operations, MCC/MOC and line maintenance departments. Colour-coded icons indicate issues such as the presence of a 'No-go' defect, or a 'Go' defect that has limited deferment time remaining.

recorded nothing found for other faults, they will sign a certificate of release to service (CRS) on the techlog. The paper techlog has 3-ply copies. One remains in the techlog that is kept on the aircraft to inform flightcrew of the aircraft's current maintenance and technical status. The second copy is removed the next time the aircraft is at its homebase, and the information on the removed pages is later manually keyed into the airline's maintenance and engineering IT system (M&E System). The third copy is removed and kept by the line maintenance station, which will fax, scan or email it to the airline's MCC/MOC. It will then be entered into the M&E system, and sent to the technical records department.

Inherent problems

There are several weaknesses in recording and reporting these faults manually on a paper techlog. These all ultimately lead to delays in defects being reported and relevant parties being made aware of them, errors and inaccuracies reporting them, high costs being incurred for managing them, and a negative impact on on-time performance and customer perception.

One particular problem with the three or four categories of faults that do not generate CMC codes, is that the flightcrew or cabin crew members that enter the defects on the paper techlog have to describe the type of fault with the two digits of the relevant ATA chapter, plus a second pair of digits for the ATA sub-chapter. The crew member often writes their own description of the fault.

Often, however, the crew entering the techlog do not know the correct digits for the ATA chapter and sub-chapter. Instead they are only aware of the description used in the aircraft operating manual, so they often enter vague and incorrect descriptions.

The result of this is that the faults can be repaired incorrectly, or even left because nothing was found. They can re-occur several times before being properly recorded and reported, and so become repetitive defects.

A second main problem with a traditional paper system is that the maintenance status shown on the techlog carried on the aircraft differs to that shown in the M&E system, because it can be two or three days before they are synchronised. In the meantime, a line mechanic can examine the defect on the techlog held on the aircraft, and perform maintenance to rectify it. This increases the length of time the MCC or MOC department takes to assess an aircraft's maintenance status.

An underlying issue is that the number of deferrable defects an aircraft carries can gradually increase over time. These will be 'Go' items. Their rectification can require some time for planning and preparation, which is not available in the aircraft's operating schedule. This is especially the case where MCC/MOC and line mechanics are unaware of the defect until the aircraft has landed. Fixing a broken toilet or coffee machine, or replacing a section of carpet also requires the preparation of task cards, arranging tooling, parts and materials, and organising manpower with specific skillsets and licences. The aircraft must also be in a particular location and have sufficient downtime to implement the fixes.

The number of outstanding defects can therefore gradually increase over time, especially with long-haul aircraft that are frequently away from homebase overnight. Many airlines have one day of downtime for long-haul aircraft every five or six days for such defects to be cleared. These small checks are used as a maintenance clean-up.

One indicator of this problem is the average number of outstanding defects per aircraft over the course of a year. This is generally a high figure when using a traditional paper techlog and paper-based fault management system, mainly because of the time needed to prepare rectifications.

Evolution

Before the introduction of ETL/ELB systems for recording and reporting faults and defects, several technologies were developed involving mainly standalone items that include specialist point solutions.

The first of these were applications provided by the original equipment manufacturers (OEMs) to analyse CMC fault codes transmitted from the aircraft to inform MCC/MOC and line maintenance of their 'Go' or 'No-go' status with respect to the MEL. These are the AIRMAN, Skywise and AHM systems offered by Airbus and Boeing.

Another development was the digitisation of the technical manuals used by the engineering department and MCC/MOC. These can be accessed via portable devices, such as an iPad, carried by line mechanics, or viewed via a computer terminal with access to the operator's M&E system either in a line maintenance van or office, although this does mean that the mechanic has to leave the flightdeck.

The use of ACARS for several decades, and Satcom systems for the past couple, has digitised the line maintenance and fault management process to a degree.

The use of all these systems still does not provide a complete digital process. There is a large number of steps between a fault arising on the aircraft and the line maintenance technician signing the CRS and the fault rectification being recorded and archived in the M&E system and technical records. Even with the connectivity systems and solutions now available, there are many switches between the traditional manual and paper process, and use of digital technologies.

Complete digital

The element that makes a complete digital system possible is the introduction of ETL/ELB software via the electronic flightbag (EFB) hosted on a remote device, such as an iPad or other tablet computer carried on the aircraft.

The ETL can be interfaced with the aircraft's avionics systems, which send it CMC fault codes. The ETL also has pages for flightcrew to enter the four categories of non-CMC fault code defects.

Airlines can choose to have both in-flight and on-ground connectivity. Most commonly, the ETL/ELB connects with the aircraft's external connectivity system via a WiFi signal on the flightdeck. While the WiFi signal and on-ground connectivity systems are used to transmit data from the ETL/ELB to the various parties in the ecosystem, they also serve as a communication link between the flightcrew and mechanic when they are outside of the aircraft. The mechanic can therefore be informed of defects by the pilot via this connectivity link, rather than the mechanic having to wait before all the passengers have disembarked to enter the flightdeck and consult with the flightcrew. This therefore increases the time available for a mechanic to deal with a defect.

Standard descriptions of what the non-CMC faults and defects are can be selected from a menu on the ETL/ELB. Many ETL vendors use a fault description tree, which lists the most appropriate description of each fault. Each one can also have a related six-digit code based on ATA chapter and sub-chapter, so that the fault can be cross-referenced with the relevant technical manuals. This menu system avoids crew members making errors by having to manually enter a defect description, which therefore avoids and reduces the incidence of repetitive defects, since defects are described more accurately.

Some ETL/ELB vendors host the MEL and all other relevant technical manuals on their devices.

Other features provided by most ETL vendors include: the flight log pages; a summary page of all current outstanding defects and their remaining deferment time; the routine and out-of-phase (OOP) line maintenance tasks coming due; and the facility to take photographs of breakages, which can be added to the description of a non-CMC fault code defect.

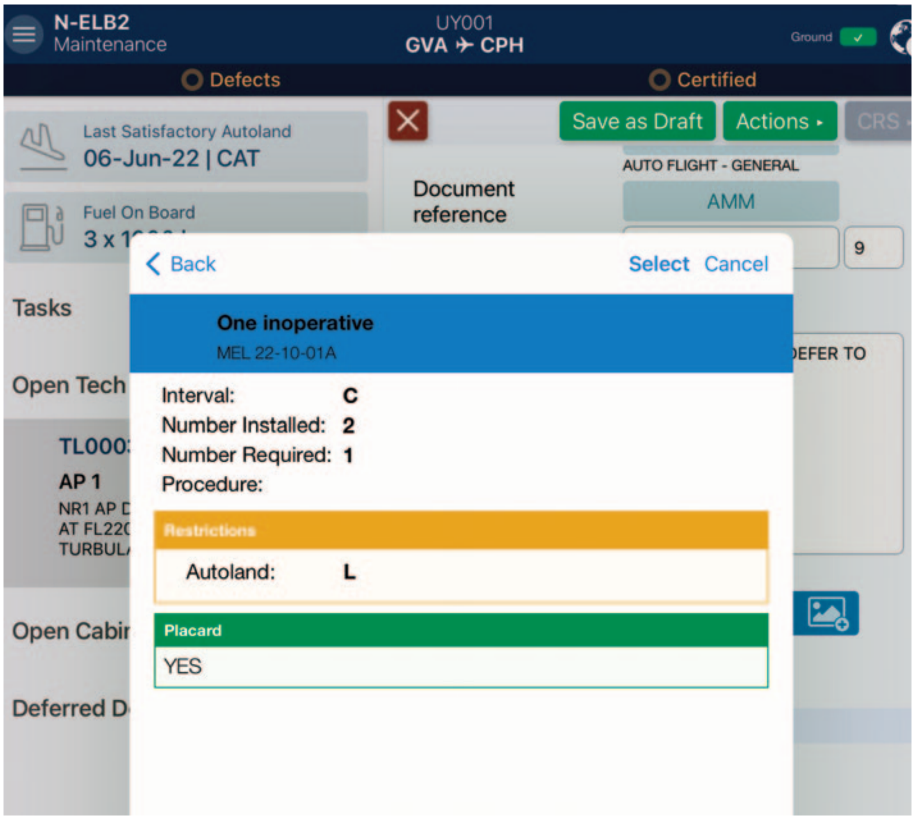
All types of faults can therefore be logged and held in digital form on the ETL. With the appropriate flightdeck connectivity systems, faults can be transmitted to the operator's MCC/MOC and entered into its M&E system, as well as the fault analysis and MEL systems.

These digital fault analysis systems can be worked together with predictive maintenance systems. "These are used to take long-term health and performance data from complex components and systems to indicate when they should be removed before failing," says Chris Clements, sales representative at Swiss Aviation Software. "This means component removal can be planned for a convenient time, rather than failing at an inconvenient time and causing ann AOG.

"The ETL and all nodes of the technical defect and fault management ecosystem have to be interfaced with the M&E system. These nodes are line maintenance, line maintenance planning, engineering, schedule planning and MCC. Moreover, all the relevant nodes of the ecosystem need to have access to the MEL and fault classification system," continues Clements. "The overall fault management ecosystem also benefits from access to stores inventory, since parts will be constantly requested to fix faults as a fleet continues to operate. This seamless interface between all nodes involved reduces manual intervention, which would slow down the process."

With the faults entered in digital form from the start, and with interfaces with all other management systems, it is therefore possible to have a complete digital system for dealing with both defects and routine line maintenance.

Several vendors also provide mobile devices and applications for line maintenance mechanics to: view messages from the ETL and the airline's MCC/MOC; access e-technical manuals; communicate with supervisors and



Ultramain's ELB. The layout is design to provide users visually simplified information with respect to the defect status of an aircraft, as well as flight log information and data.

technical departments; request parts and tools; and receive and use task cards for rectifying defects and faults.

M&E system and ETL/ELB vendors also provide specialised apps and software. Trax offers its web-based Planning Control app to collate defects, parts, resources and manpower. This is accessed via iPads, and is used to coordinate a fault rectification and fix.

Another Trax app is its QuickTurn system, which collates the Tech and Cabin logs and all line maintenance activity within one app. It also offers Aerodox for viewing and searching through digital manuals, and Task Control, which is used by mechanics to perform maintenance on electronic task cards.

Cathay Pacific

Cathay Pacific operates a mix of intra-Asia Pacific and intercontinental routes with a mainly widebody passenger and freighter fleet. Many of the intercontinental routes are ultra-long distance. The main types in the fleet are the 777-300ER, A350-900/1000, A330-300 and A321neo. It also operates 747-400ERF and -8F freighters.

Cathay Pacific has used the Ultramain M&E system since 2002, and later selected Ultramain's ETL system, originally as a class 3 installation, before moving to Ultramain ELB (mobile) on iPads in 2016. The Ultramain electronic log book (ELB) comprises both eTech Log and eCabin in on integrated application.

Cathay Pacific has a contract with local maintenance provider Hong Kong Aircraft Engineering Company (HAECO) for line maintenance and larger hangar checks. Line checks can be performed at the gate at Hong Kong International Airport (HKG), but aircraft are towed to HAECO's facilities or remote parking stands for light checks, which is some distance from the aircraft stands at HKG. The A321neo line maintenance is contracted to China Aircraft Services Ltd (CASL).

"When we introduced the ELB into Cathay Pacific, it was a big change for all departments involved in aircraft technical management and line maintenance," says Jim Down, maintenance control manager at Cathay Pacific. "This was after decades of using a paper-based system, so it was critical to get the training right for everyone involved in the process.

"The ELB was an important addition to the overall maintenance system in CPA. The application client is loaded on iPad devices for the aircraft and ELB ground system on the server. The fleet dashboard is accessed through a browser as a read-only application," continues Down. "The flightcrew and cabin crew interface with the ELB by a pair of synchronised iPads kept on the aircraft. This is where they enter the normal flightlog and defect information. Engineers and mechanics then use the ELB to record the required work carried out with respect to technical defects and servicing.

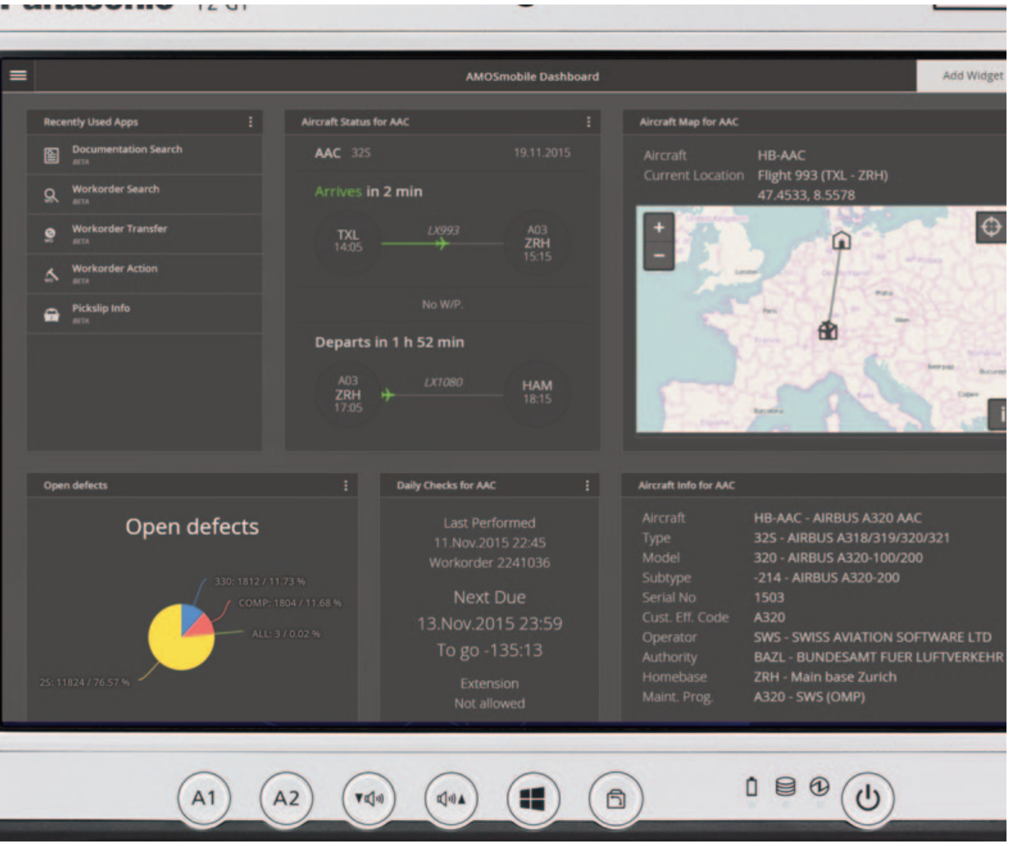
"The ETL provides all the information found in a paper logbook, such as flight sector information, servicing information, defects raised by flight crew and engineers, deferred defects, and notices to crew. It also enables many convenient functions as you would expect from a digital system. For example, there is a de-ice/anti-ice monitoring function to assist with monitoring of the 'hold-over time' for the applied de-icing fluid. There is also a function to provide the user with information on maintenance check status, and reporting defects using a 'fault reporting tree' enables accuracy," adds Down.

Cathay Pacific's MCC uses a variety of information systems to monitor aircraft operational and technical status. Display screens in the Integrated Control Centre provide aircraft operational and environmental information including weather, aircraft flight tracking, aircraft AOG status, and a map of aircraft positions at HKG airport.

"We have several systems used by engineering teams to monitor the defect status of individual aircraft. We use an operations control system in the Integrated Operations Control Centre, (IOC) to manage aircraft activity including flight and maintenance details," explains Down. "Defects are monitored and highlighted through this system to provide vital operational status to the organisation. We also use Airbus AIRMAN and Skywise and MyBoeingFleet AHM to monitor live technical status. With these the OEMs generate performance metrics for CPA and we use other software or applications such as Microsoft's Power BI to generate dashboards to report and monitor technical performance metrics.

"With the previous paper techlog, defects were cleared by line maintenance. The CRS was signed and the aircraft dispatched, and then the data and information was manually keyed into Ultramain M&E system. With a large fleet and busy operation a lot of paperwork is generated, resulting in a huge quantity of technical records being produced with an associated heavy administrative burden," continues Down. "There were contractual arrangements for the MROs to input all the aircraft technical log data from the paper logbook into the M&E system within an hour of the aircraft's departure. Visibility of check or defect status is therefore not possible with this manual system."

Down says that with the introduction of the Ultramain ELB, the requirement for manual data entry no longer exists. As soon as the ELB connects to the ground system, all defects are immediately visible



Swiss Aviation Software's eTLB, as displayed on a Panasonic Toughbook. The system graphically display flight log and open defect information and data.

whether open or closed.

"Our M&E system is linked intrinsically with the flight operations planning activity," says Down. "We need to know if a particular defect will place any operational restrictions or limitations on an aircraft. An example is a defect that can affect an aircraft's ability to operate extended range twin-engine operations (ETOPs) routes. In this case we may need to swap aircraft in the fleet from their assigned routes. This switching can cause schedule delays, but the ELB can help to avoid or reduce these, as a result of the early knowledge of the performance limiting defect, since the transfer of data and information is seamless and quick in the line maintenance process."

Cathay has equipped all of its fleet with the Ultramain ELB hosted on iPads which are connected to the ground system via SIM card or WiFi. The iPads can also be connected inflight through aircraft Wi-Fi connected through SATCOM connectivity systems.

"We have cellular connectivity for on-ground data transmissions. Inflight transmissions rely on satellite Ka-/Ku-band satcom connectivity that is available on many aircraft," says Down. "The transmission and the digitisation of defects and faults in-flight allows for more time to organise a managed response."

"A big benefit of the ELB system is that we get more accurate information about a defect. The defect fault tree assists with guiding the engineer to use the correct fault code and description of the defect," says Down. "This helps because many people across our operational network are not native English-speaking, and so having predefined descriptions of defects is a big help."

With the ELB deployed, Cathay Pacific now has a seamless flow of data and information from the fleet into the M&E systems, and it provides benefits to tracking defects."Maintaining control on defects is a key performance indicator and a requirement for all operators" says Down. "Ensuring that defects are reported, managed and rectified in a timely manner ensures that operational disruptions are minimised which naturally is reflected in the bottom line of the airline's profits."

CPA monitors and manages recurrent defects (those defects that repeat within a given timeline) and Acceptable Deferred Defects (ADDs). "We have set a target number of ADDs per aircraft on each fleet type, and we aim to keep the actual number below this level," says Down. "The number of open ADDs is only one measure of health of the aircraft. The time taken to clear the ADD provides insight into the aircraft's health, and the maintenance system as a whole. With the ELB, its functionality is contributing to enhanced management and oversight of defects, with a net benefit to the maintenance system. Reducing the life cycle of an ADD has reduced the number of deferrals."

The Airbus 'Aircraft Condition Monitoring System' (ACMS) is an on-board maintenance system. The main function of the ACMS is to collect, process and store data from a large number of aircraft systems.

The ACMS supplies the aircraft operator with performance and trend information about engines and other aircraft systems.

The ACMS supports scheduled and preventive maintenance by monitoring the efficiency and degradation of aircraft systems.

With the latest generation of aircraft, nearly all of the systems are controlled and monitored through digital networks, and this has enabled a massive amount of data to become available providing the opportunity for preventative maintenance and detailed troubleshooting from the on-board maintenance terminal.

The ELB supports the leap forward in information flow through its ease of use, capacity, accuracy and timely information into the M&E system.

"Another improvement that can be realised through in-flight connectivity of the ELB is the in-flight reporting of technical and cabin defects," continues Down. "In-flight defects are communicated to the arriving station, enabling the ground engineer to investigate and plan the strategy to deal with the incoming defect ahead of the aircraft arrival. This valuable time-saving makes for a much more controlled management of the defect where on-time performance, or plans can be set in motion to manage any disruption, which ultimately preserves the passenger experience."

The ELB application has a digital version of the aircraft's MEL loaded into it. This provides the engineer with direct references to the appropriate MEL item when deferring a defect. This reduces the risk of using the wrong MEL reference and applies the correct expiry date. The ELB has removed the risk of MEL overrun. Since some MEL items have a maintenance requirement, the engineer raising the deferral is required to reference the appropriate maintenance manual or troubleshooting manual task.

The digitisation of the operations manuals enables instant links to be created to the maintenance tasks directly from the MEL item when the document sets are embedded in the same device, or accessible on-line to the mainframe systems. The ELB can be configured this way if the operator so choses.

Down cites the saving of administration costs, including managing paper log books, storing and preserving records, data entry, are significant benefits

Having experienced success with Ultramain's ELB on its A350-1000 fleet, British Airways will roll out the system across all other long-haul fleet types in 2023, and the across its A320 family fleet in 2024.

of the ELB system. "Eliminating manual data entry into the M&E system, and the effective and efficient management of aircraft defects supports the investment in the ELB system. So the ELB has changed how CPA manages aircraft defects, and there are potentially many more benefits which the evolving ELB system will bring in the future," concludes Down.

British Airways

British Airways (BA) introduced the A350-1000 into its long-haul fleet in 2013, and implemented the Ultramain ELB system in June 2019. The ELB is interfaced with BA's M&E system, which is customised SAP software.

"Our A350 fleet is equipped with ACARS linked to legacy and Inmarsat Swiftbroadband satcom connectivity systems for in-flight data transmissions, and 3G/4G WiFi for in-ground data communication," says Scott Falkiner, technical engineer eOperations at BA. "These systems are all line-fitted on the Airbus production line.

"We also use the Airbus AIRMAN and Skywise systems for diagnosing faults as they are received from the aircraft. This is virtually in real time, since it takes about eight seconds to transmit them from the aircraft to Skywise and our M&E system, based at BA Waterside near London Heathrow (LHR) airport," continues Falkiner. "We have a variety of display screens at MCC, each one showing different information. One of these displays will be the ELB ground server, which shows the status of the A350 and 787 fleets. Another display shows the information generated by AIRMAN, while another shows the Boeing AHM screen. There is dual transfer of defect data to all the M&E departments that are concerned with each aircraft's maintenance status and the outstanding defects. The whole system configuration makes it significantly easier to manage immediate and medium-term defects."

Falkiner adds that there are few or no errors in fault reporting. "With the traditional paper-based system, pieces of paper with an ADD reported on them with a three-day deferment allowance could be ignored for two days. This does not happen with a digitised system. The use of accurate descriptions in the fault description tree also means that the quality of the information is better. There is also the ability to take photographs of defects, and attach these to the description.

"The CMC fault codes and the ECAM messages that are generated by the aircraft's systems are automatically transmitted to the AIRMAN and Skywise systems, although they can also be entered manually into the ELB by the pilots if they notice them, although it is not always the case," says Falkiner. "Pilots enter the defects that they observe, and those in the cabin, into the ELB, and then send them to SAP while the aircraft is in flight. SAP has a list of outstanding defects and their categorisation for every aircraft in the fleet.

"The Ultramain ELB also hosts the MEL, which is used for deferring defects with the correct limits. All the other eTech manuals are stored in an online documentation system," continues Falkiner. "There are several groups in the airline that monitor the ADDs on every aircraft. Maintenance planning monitors the length of time that each defect can be deferred for.

"Our maintenance planners know the planned operating schedule for each aircraft in the fleet, the location of the spare parts at BA's various facilities, and so know when it is best to rectify faults and defects," says Falkiner. "As all the information is instant, the number of ADDs on each aircraft do not build up as they do with older types that use a paper-based techlog. Overall, there is generally a better awareness across the airline of each aircraft's technical status.

"As a comparison, we operate a paper techlog system for our A320 fleet and there is always about a 24-hour delay between faults occurring and them being entered into SAP," continues Falkiner. "Many of the defects are actually fixed by the line mechanics before they are entered into SAP, so overall it is about 48 hours before the status of the defect on the copy of the techlog held on the aircraft matches the status held in SAP. The use of an ELB and digital line maintenance system saves labour man-hours (MH) that are used to manually key defects and faults into the M&E system. We do not use any support staff for these activities on the A350 fleet. A main difference for us is that ADDs are outstanding for a shorter period of time. Things that require a lot of planning to rectify are big fixes in the cabin, such as a stain on the carpet, which can be deferred for up to three weeks. This can now be shortened because the planners have all the information.

"It is significantly less stressful managing faults and defects, and the cabin crew also report a positive response from passengers because they can see defects being reported when they speak with the cabin crew," continues Falkiner. "The Ultramain ELB can also be fed task card data from SAP, although there are too many practical implications to make this currently viable for use. A lot of system work is required to make this happen.

"We plan to implement the ELB with the 787 fleet. The Ultramain ELB will replace the in-built system originally supplied with the aircraft," adds Falkiner. "We also plan to introduce the ELB on our A380 and 777 fleets during 2023, so all of our long-haul aircraft will have the ELB system by the end of 2023. We then aim to start using the ETL on the A320 fleet from 2024. Once we have rolled out the ELB across our whole fleet, we expect to realise a large saving by reducing support staff numbers and the use of paper and technical records storage."

EL AL's maintenance digitisation programme was implemented across its main three fleet types. This features the use of Swiss Aviation Software's Mobile/EXEC application through iPads. The airline will start to implement the eTLB across the fleet in 2023.

EL AL

EL AL Israel Airlines (EL AL) operates a fleet of 45 Boeing aircraft, and has recently digitised its maintenance. The airline and its engineering department have used Swiss AMOS as its M&E system.

"We digitised our maintenance by first acquiring and interfacing Swiss Aviation Software's Mobile/EXEC application through an iPad, and using it for most of our aircraft maintenance," says Danny Laredo, paperless project manager at EL AL. "We use this for all levels of airframe maintenance, except for dealing with technical log defects. These are still managed with a paper techlog. We have, however, chosen Swiss Aviation Software's electronic technical logbook (eTLB), which is in its final stages of development.

"We will test the eTLB on a few aircraft in the middle of 2023, and start to roll it out across our entire 737, 777 and 787 fleet in the last quarter of 2023 and early 2024," continues Laredo. "We will use the eTLB software on the iPad. This way all technical aircraft defects, reported by pilots and the cabin crew, will be managed through the iPad, so all airframe maintenance will be digitised."

There will be about 1,000 iPads in service with EL AL's pilots, cabin crew, mechanics and engineers. The iPads are equipped with SIM cards, and the fleet is equipped with both 3G on-ground connectivity for data transmission at the gate, as well as a high-bandwidth satcom system from Viasat. The satcom system is already used for in-flight entertainment, but it will also be adapted for data transmissions to and from the eTLB.

"All other levels of line maintenance are already performed via the Mobile/EXEC app, and we decided that it was best to have an app for the logbook from the same vendor on the maintenance ecosystem," says Laredo. "The iPad also hosts the Boeing Toolbox for electronic technical manuals, including the FIM, AMM and IPC. Having everything within the same device makes it convenient for all users, who will also have the ability to perform rectification tasks and sign the CRS through the eTLB, which will therefore be interfaced with Mobile/EXEC.

"Sending technical reports live, while the flight is in progress, means the technician can work proactively to diagnose the defect and prepare rectification action if required. This will increase the time available to deal with a 'No-go' defect, so delays should be shorter," continues Laredo. "The technician will be able to request parts and tooling, communicate with other departments, receive a work order and task card, and sign the CRS through the eTLB.

"We see the main benefit being a 10% saving by eliminating technicians' wasted activities chasing paper, searching through manuals, looking for parts and tools, and moving between locations," adds Laredo. "The problem with a paper system is that pages can get lost or torn, dirty and defaced and so have to be handwritten again, and their contents manually keyed into the M&E system. We do expect to save money on paper because of reduced technical records, and there will also be improved maintenance planning because time will not be spent printing task cards."

Laredo expects the management of ADDs to change. For example, cabin crew will report more cabin defects because it will be easier than with a paper tech log.

Benefits

The ETL therefore allows maintenance data to be transferred seamlessly through the entire fault management process. Following implementation, an airline will experience multiple benefits.

The first improvement is timeliness and the accuracy of defects as they arise, especially with aircraft that have the appropriate air-to-ground connectivity systems. The MCC/MOC and line maintenance departments have more time to diagnose faults. They can make timely decisions with respect to the MEL, and categorise faults as either 'Go' and defer them, or as 'No-go' and immediately start planning their fixes.

This reduces delays, some of which are caused by faults not being found by a line mechanic, or because time is required for diagnosis to determine their MEL status.

The digitisation and seamless transfer of data will synchronise the information relating to defects and their status between all systems and applications.

Entries on paper logs no longer have to be manually keyed into the M&E system, so an additional advantage is an improvement in task description accuracy and labour savings. Airlines can gradually improve labour efficiency and costs due to natural staff attrition.

The earlier diagnosis of defects as 'Go' items, which accumulate in number during operation, allows more managed planning for their rectification. The nature of small defects means that they are small issues, which can be cleared relatively easily during turnarounds between flights or daily checks. As diagnosis is easier and quicker, rectification planning is less pressured, so rectification clearing can be made more frequently. The average number of outstanding defects carried on an aircraft can therefore be reduced. It has to be appreciated that normal weekly checks in an aircraft's maintenance plan only have a 90-120-minute downtime for actual maintenance. Total aircraft downtime for this check may need to be an additional two hours because of time required for aircraft towing. AC