Despite the advent of intelligent digital documentation, many airlines are still generating cards in paper and signing them manually. The technological steps to achieve a system of electronically generating cards that will accept on-screen signatures, and collecting man-hour & material inputs electronically while monitoring check progress are examined here.

The path to a fully electronic system for job & task cards, technical records & SFDC

Having a streamlined system to electronically generate and publish job and task cards for each element of maintenance is an aim of many airline engineering departments and maintenance repair and overhaul (MRO) providers.

Most airlines and operators no longer keep all manuals and documents, and generate job and task cards on paper. Their ultimate goal is to have all manuals and documentation in an electronic, digital and intelligent format, so that: job and task cards are created with a minimum of manual input; electronic cards (e-cards) are sent to desktop computers or mobile devices; cards are signed electronically without the need for manually-signed printed paper copies; all shop floor data collection (SFDC) labour and material inputs are recorded electronically; and all technical and maintenance records are electronic without scans of paper records.

Evolution

"Big airlines all used to keep the text and data for the maintenance planning document (MPD), job and task cards, and other related documents on a mainframe system," says Chris Reed, managing director at Trax. "Diagrams and illustrations were provided on paper documents and manuals directly supplied by the original equipment manufacturers (OEMs), and used by planning engineers to generate job and task cards. Smaller airlines generated job and task cards entirely from paper manuals by photocopying pages, cutting out relevant parts and pasting them."

Documentation began to be supplied in CD-ROM format during the 1990s on proprietary software vendor formats. This was still in a basic text and graphical format. Later documents were provided in portable data format (PDF), a standard developed by Adobe for driving printers. Initially this provided a common format that allowed entire documents to be distributed as a single picture or segments of pictures managed by a table of contents. This meant complete job and task cards, or other documents, could be sent by planning engineers to MROs or mechanics, for example, rather than individual elements of a card being sent, for the recipient to put them together.

At about the same time the first client-server maintenance & engineering (M&E) IT systems became available, but these were improvements on their predecessor mainframe or proprietary mini-based systems. The M&E systems were built around SQL, to manage parts, aircraft configuration, check intervals and aircraft utilisation. They were not capable of managing electronic documentation and content of manuals.

With these systems in place, when documents and manuals were changed by the OEMs through upgrades and revisions, all the relevant in-house manuals and documents would have to be updated manually, often using photocopiers, scissors and glue.

Intelligent documents

Manuals and documents started to be provided as intelligent digital documents in standard generalised mark-up language (SGML) format for the first time in the 1990s. The 767 was one of the first types to have its content provided in SGML. The majority of content for all aircraft has since been provided in SGML, although some was also provided in .PDF. The typical PDF, however, is now structured and can be managed by its table of contents, and fragments can be searched and found. Adobe's Acrobat allows advanced capabilities in PDF.

A later development of intelligent documentation came with extensible mark-up language (XML). The first and only aircraft to use this so far is the 787. The A350 and CSeries will also use this when they enter service.

"The first main reason for using intelligent documentation is its ability to search, find and navigate through documents because of their marked-up or 'tagged' content," explains Thanos Kaponeridis, chief executive officer at Aerosoft Systems Inc. "These tags can be used to create links between related manuals, such as the aircraft maintenance manual (AMM) and the illustrated parts catalogue (IPC)."

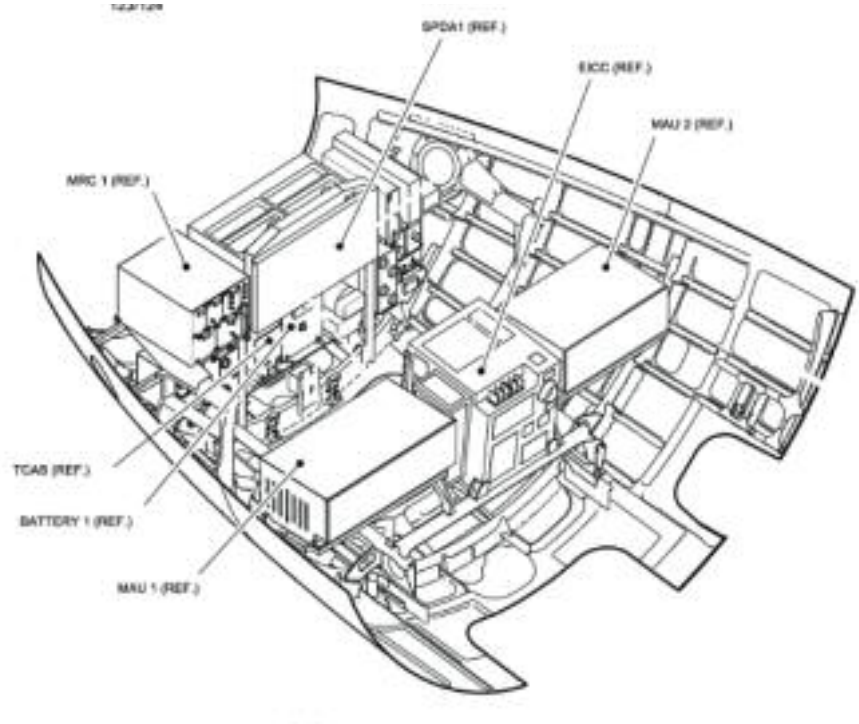
The AMM page, for example, may have an instruction to use a particular part number, found in the IPC.

OEM revisions and updates to the AMM, for example, can also be changed automatically in the related manuals because of the links. This, however, also requires the use of a content management system (CMS).

The second main reason for using intelligent documentation is that the data can be re-used to electronically generate job and task cards. "Document type definitions (DTDs) enforce what can be selected and where it can be re-used depending on the DTD of the source and target document. With SGML, however, you do not need to cut and paste, you can create 'views' of new derivative documents with pointers to the original data," explains Kaponeridis.

XML was derived from SGML and it can be used with DTDs or schemas for tagging (describing the structure) of

The advent of intelligent digital documents and manuals in SGML and XML format means their content is tagged. These tags allows links between related manuals to be created. This is useful for searching through documents, automatically applying updates & revisions, and generating task cards.



documents or databases. XML has XSL (for style definition) and XSLT (for transforming one structure to another). As such, structure, content and a variety of output formats (screen HTML, paper/.PDF, API/XML) can be generated. Job cards can be built again as references from the MPD, the AMM, the IPC and also the M&E system's up-to-date information using XML.

The original design of M&E systems had no, or limited, capability to handle intelligent documents. They were simple, because XML was defined as a standard after they were architected. A few M&E systems have recently added technical documentation (or 'Tech Doc') modules, but still manage content within the limitations of their SQL databases.

If M&E systems cannot handle XML and SGML, airlines have to keep using manuals and generate job and task cards in PDF or paper format. An alternative is to use the OEMs' documentation and job card management services.

OEM documentation services

An airline has to subscribe to an OEM's basic service in order to receive documents and manuals, regular revisions and updates, and standard maintenance planning document (MPD) and standard job and task cards for its aircraft. These services are available via the internet.

Boeing's basic service is available through its www.myboeingfleet.com on-line service. This provides access to all the manuals, and regular updates and revisions, as well as the standard MPD and task cards. All data are in .PDF.

The OEMs also offer more comprehensive or premium services. Data are provided in intelligent SGML/XML format. Many airlines prefer, however, to customise maintenance programmes, documents, job and task cards. These comprehensive services allow airlines to store their own edited and authored job and task cards, manuals, and other documents such as approved repair schemes on the OEMs' hosted documentation services. Airlines can therefore manage their maintenance programme and documentation, and generate job and task cards on the OEM's hosted service if their own M&E system cannot handle SGML/XML data.

Boeing's premium product is maintenance performance toolbox (MPT). Airbus provides its document and card production service through its AirN@v product.

Job card production

Maintenance planners in most airlines will load the MPD job card numbers into an M&E IT system, or will refer to an OEM's internet document services. Airlines can use either the OEM's standard numbers for the AMM, where the MPD job card is detailed, or their own numbering system. MPD and AMM numbers will be in the M&E system. The maintenance planner will use this and other information such as required skills, tools, aircraft registration and line number, and manufacturer's serial number (MSN) to generate job cards.

Airlines and MROs have their own standards for laying out job and task cards, including signature strips for the mechanic and supervisor, and space for notes.

Non-routine job and task cards have a different format to routine cards to allow descriptions of the findings and the correction action to be recorded. Extensive descriptions of repairs or corrective action from several manuals, such as the AMM and structural repair manual (SRM), often have to be included. Many airlines have written standard non-routine cards for frequently used items.

Routine and non-routine cards both need spaces for different mechanics to sign off on the card, since some job cards can overlap two or more workshifts.

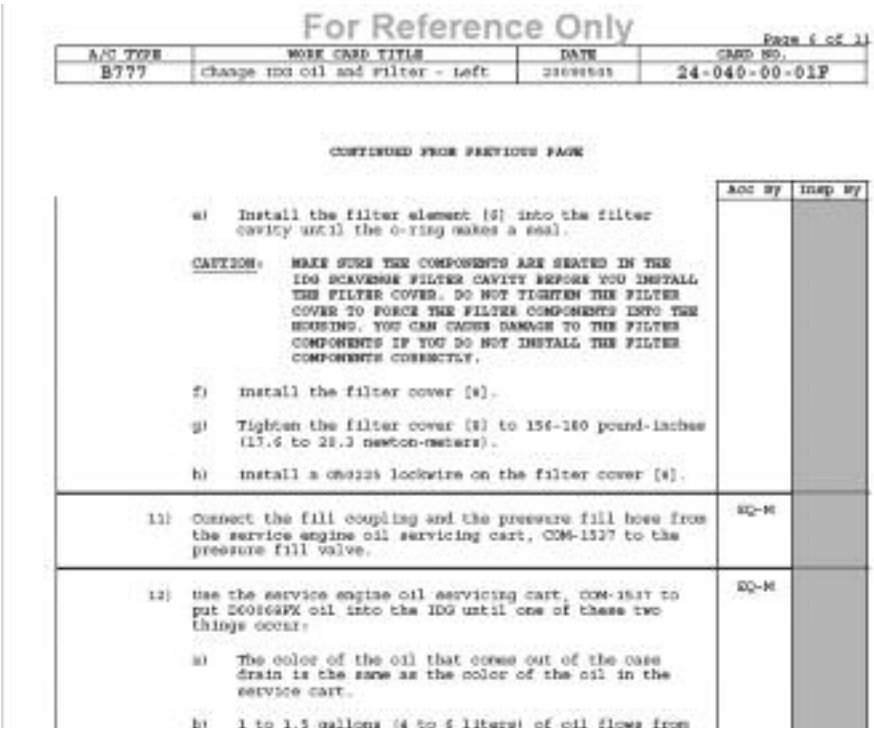
The airline's own edits and additions also have to be considered. "Predefined job cards from the OEMs come with a sequence of tasks and a description of what has to be done to complete the task," says John Snow, vice president of marketing and business development at Enigma. "When a revision is issued by the OEMs, one or several job cards will be affected. OEMs try to get airlines to use standard job cards, provided by the on-line documentation services. Most airlines do not want standard OEM cards, however, because they want to make their own revisions, such as adding MSN, registration and their own work order number. While the OEM's standard cards can be generated electronically, many airlines have to manually add their additional information, and scan them to make them electronic again."

CMS assistance

M&E systems' limited ability to handle SGML/XML content, and therefore their inability to automatically manage upgrade revisions, and generate job cards electronically, meant that most airlines had only one choice if they wanted to use SGML/XML data: to rely on the OEMs' on-line services to manage revisions and updates, and generate job and task cards on their hosted systems.

This system was far from perfect. While the OEMs' premium services allowed airlines to author, edit and customise job cards, the systems would not be informed if, for example, a service bulletin (SB) had been applied to an aircraft. The airline's own M&E system would be informed, but the change made to the aircraft would then have to be manually input into OEMs' systems, so that the right job card was applied to the aircraft in the future.

The two problems of: i) most M&E systems' inability to handle SGML/XML data and ii) the lack of a link between


For Reference Only

A/C TYPE	WORK CARD TITLE	DATE	CARD NO.
B777	Change IDG oil and filter - Left	[illegible]	24-040-00-01P

CONTINUED FROM PREVIOUS PAGE

	Acc By	Insp By
e) Install the filter element [6] into the filter cavity until the o-ring makes a seal.		
CAUTION: MAKE SURE THE COMPONENTS ARE SEATED IN THE IDG SCAVENGE FILTER CAVITY BEFORE YOU INSTALL THE FILTER COVER. DO NOT TIGHTEN THE FILTER COVER TO FORCE THE FILTER COMPONENTS INTO THE HOUSING. YOU CAN CAUSE DAMAGE TO THE FILTER COMPONENTS IF YOU DO NOT INSTALL THE FILTER COMPONENTS CORRECTLY.		
f) Install the filter cover [8].		
g) Tighten the filter cover [8] to 156-180 pound-inches (17.6 to 20.3 newton-meters).		
h) Install a chain lockwire on the filter cover [8].		
11) Connect the fill coupling and the pressure fill hose from the service engine oil servicing cart, COM-1537 to the pressure fill valve.	EQ-M	
12) Use the service engine oil servicing cart, COM-1537 to put D00168PX oil into the IDG until one of these two things occur:	EQ-M	
a) The color of the oil that comes out of the case drain is the same as the color of the oil in the service cart.		
b) 1 to 1.5 gallons (4 to 6 liters) of oil flows from		

Many airlines are still generating paper job & task cards. MROs face several problems when generating job cards for customers. These include different formats and design layouts used by each of their customers, as well as various sources of the originating documentation.

airlines' M&E systems and the OEMs' systems to inform of changes to aircraft configuration developed a need for airlines to interface their systems with a content management system (CMS). Most functions performed by the two can be clearly distinguished.

The M&E system has several main functions: it maintains all data relating to the aircraft in the fleet, including line number, MSN and registration; maintains the component configuration of each aircraft; maintains the master parts list (MPL) (which should come from the IPC, which should be in the CMS); keeps flight hour (FH), flight cycle (FC) and calendar age data for each aircraft in the fleet and its components; and holds information on maintenance package timing.

A few M&E systems have a basic system for managing documents and manuals. These allow SGML/XML cards and OEM documentation to be stored and edited on the M&E system.

Another M&E system function is to sequence job cards, and allocate labour and mechanics, and tools and facilities to workpackages. M&E systems also monitor the progress of checks as tasks are completed. Some also collect SFDC data in relation to man-hours (MH) and materials used on each job and task card.

A CMS system is now being used by a select group of mostly tier-1 airlines as an interface with their M&E systems. Many airlines that have implemented M&E systems are still in the process of selecting CMS systems. The main CMS providers are Enigma, InfoTrust, Corena, IDMR, TerraXML, and Aerosoft/DigiDOC.

A CMS's prime task is to hold all digital content of documents and manuals that are provided in an intelligent format. The links established between the manuals should allow all revisions and updates to be handled automatically each time they are issued by the OEMs.

A CMS manages the IPC and MPL, and electronically authors, edits, generates and publishes job and task cards as required by the M&E system. It can also be used to search for parts, and record findings from routine tasks.

M&E & CMS synchronisation

The M&E system has to be synchronised with the CMS. The way the two work together will vary from airline to airline.

One way is for the CMS to handle revisions and updates, and pass the latest approved version of documents, manuals, and job and task cards to the M&E system. The two systems have to be synchronised so that the latest version of the AMM in the CMS is used by a planning engineer when preparing a check in the M&E system, and also by mechanics performing a check.

With data in SGML for many aircraft types, or in XML for the 787 and other types, revisions and updates issued by the OEMs would ideally cascade automatically through all the affected and linked documents and data in the CMS and M&E system in just a day or two. Job and task cards could be generated with the latest revisions soon afterwards.

Air Canada Jazz is a Trax customer. It loads OEM SGML data into Trax, and its doc manager module automatically converts each manual into XML, taking 1-2 hours for each one. The XML content is then edited before the task cards are generated.

Ramco's 5.0 system is used together with several CMS systems, including InfoTrust and IDMR. Ramco has its own module for managing documents and generating task cards.

Korean Air uses Oracle's cMRO M&E system in conjuction with Enigma's CMS. Since implementing these two systems, Korean Air has been able to deal with revisions and produce task cards with the latest data and information.

Every revision issued by OEMs is evaluated by Enigma, and applied to the MPD and approved maintenance programme in cMRO. "Within three days the documentation for Korean Air's entire fleet will be up to date," says Snow.

Between paper & electronic

While the data used to create job and task cards is now in intelligent and electronic format for more recent aircraft types, the cards themselves are still produced in paper format and manually signed by most airlines and MROs.

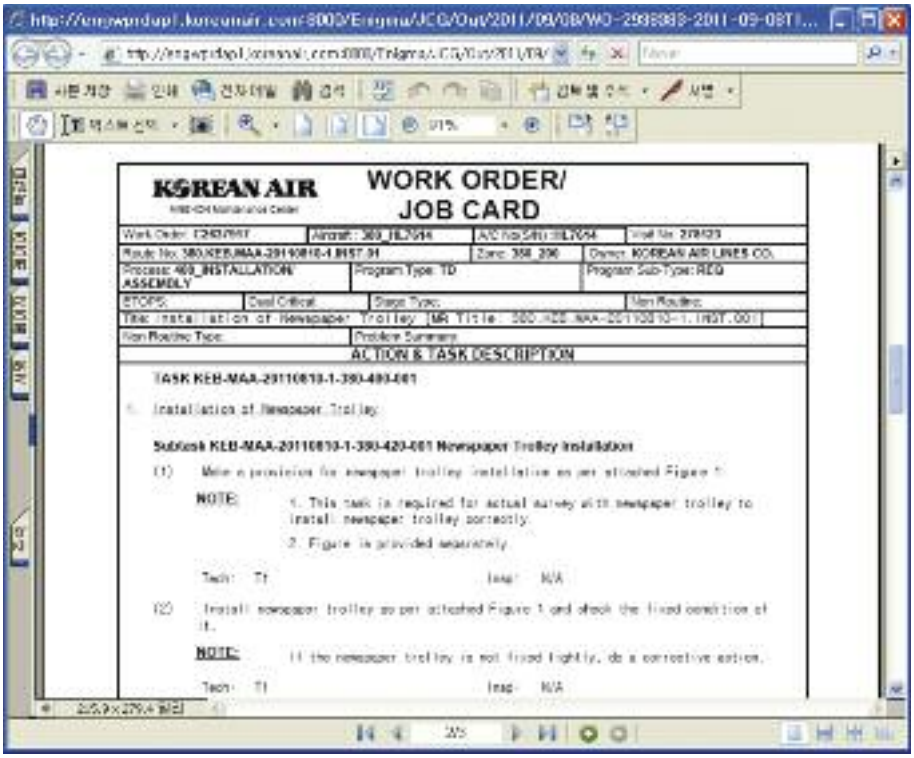
The advent of electronic sign-off more than a decade ago allowed the mechanic to sign off a job card by identifying himself with a pin number or electronic device such as a tag. Cards were signed off electronically on computer terminals in the hangar. This system's only main advantage, however, was that the M&E system was informed in real-time that each task and job had been completed. Paper job and task cards still had to be printed and manually signed. Moreover, regulatory authorities would not approve electronic signature alone, as manually-signed paper cards were still required to prove that the work was carried out.

Airlines and lessors both needed a fast way to search maintenance records, so systems evolved to scan signed paper cards. The scans can be read at high speed with optical character recognition (OCR) equipment for management purposes, while the paper records form the legal proof of the job having been performed. This is used for virtually all maintenance performed by airlines and their MRO providers.

Job cards for MROs

While it is illegal for an airline to send its AMM and entire set of documentation to an MRO, airlines send complete job cards or relevant pages from the manuals to the MRO to generate job cards.

Airlines have three options when



Some tier-1 airlines have acquired CMS systems to interface with their M&E systems. Korean Air has interfaced Oracle's cMRO M&E system with Enigma's CMS. The combined system means Korean Air can generate job & task cards with the correct information within two or three days of manufacturers issuing revisions & updates.

generating paper job cards from manuals in paper or PDF format for maintenance to be performed by an independent MRO: to make the job cards themselves; send the MRO the relevant pages from the manuals for the MRO to copy, cut and paste paper cards; or to send the relevant pages of the manuals in PDF format for the MRO to generate the job cards.

In all three cases only routine cards are generated. Non-routine cards have to be written at the MRO's facility.

The MRO provider therefore needs a system to generate both routine and non-routine cards. Once the work is signed off, the cards have to be returned to the operator. They may also be scanned. Some MROs also have electronic sign-off capability, so that it informs the airline's M&E system that tasks have been completed.

Generating task cards for independent MROs is challenging. "The first problem is that there is no international standard for a job and task card style, layout and format," says Reed. "Differences between operators come, for example, in the information on the job card, which can include: aircraft registration; MSN; line number; the OEM's job card number; the operator's own job card number and work order number; and several other pieces of information. Operators also use a different number of digits for particular identifiers, such as the job card number.

"Other differences are with the location and number of signature strips," continues Reed. "Airlines also edit and author their own cards, and like to have different styles of layout and design to the OEMs. This means airlines cannot simply use the OEMs' cards, even though they are available through on-line portals."

MyTechnic in Istanbul is an example of an independent MRO having to generate cards for a several airline and aircraft lessor customers.

"The on-line services offered by the OEMs can help us extract the data for generating the cards," says Mustafa Buzun, maintenance planning chief engineer at MyTechnic. "Boeing provides its standard job and task cards on www.myboeingfleet.com, but an airline can also keep its own edited and authored cards in the more sophisticated MPT product. MPT takes the engineer using it from the AMM to data and information in other manuals via links. Airbus's Airn@v system has two columns for signatures by mechanics and inspectors. We can therefore access an airline's customised cards by using its login details on the OEMs' portals."

"There are several different ways airlines deal with us," continues Buzun. "The easiest way is for them to send us prepared cards. Another way is for the airline to subscribe to the OEMs' on-line document services, and for us to use other IT systems, such as one of the M&E or CMS systems on the market, to electronically generate cards using the basic data and information that comes from the OEMs' systems."

There are also several other details an MRO has to consider when generating cards. One is customising a card, so that the tasks are correctly detailed with respect to the particular aircraft's component configuration, or status with respect to particular ADs and SBs. This takes a long time when done manually, but is easier with data provided in an SGML or XML format.

Electronic card generation

The use of intelligent SGML and XML data with a CMS automates many of the processes of generating cards. "The use of SGML or XML data really has little or no advantage when generating traditional job cards," says Snow. "It is possible, however, to get to the right data faster because of links between the intelligent documents. A CMS makes life easier when generating job and task cards electronically. Enigma has a job card generator which takes the relevant information from the manuals."

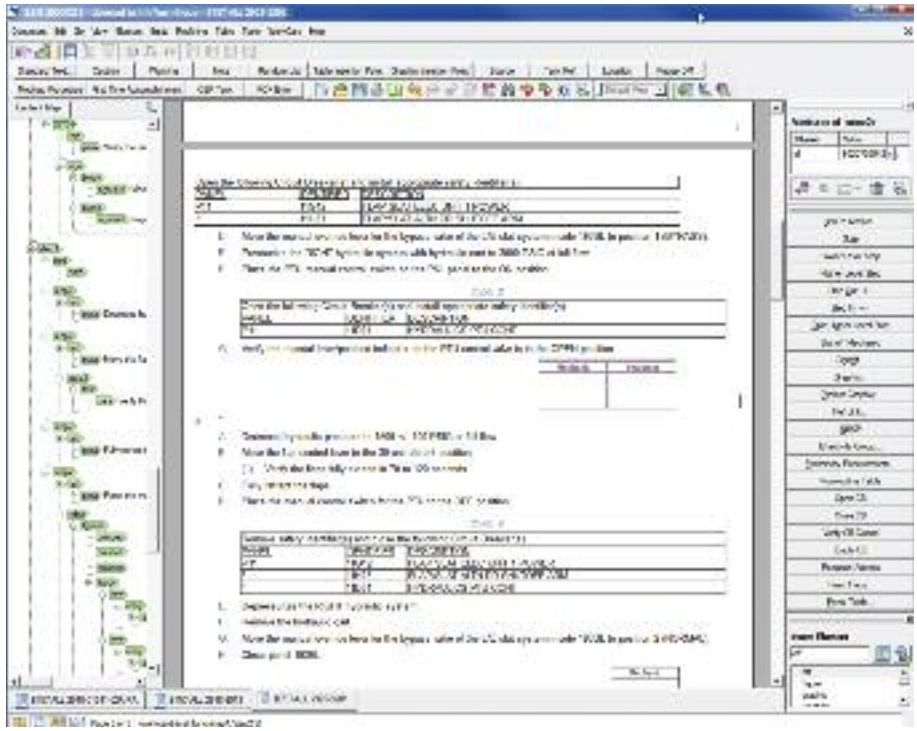
Electronic documentation makes job card generation easier in several ways. "The MPD is the basis for constructing job cards. The details of cards in the AMM are standard, but most airlines make their own additions or edits," says Tim Larson, techsight/X S1000D product owner at InfoTrust.

The use of intelligent documentation and the links between the AMM and other manuals, mean that the correct sections of text, graphics and diagrams are automatically grouped with minimum manual input. A completely automated system takes into account all up-to-date revisions, effectivities of particular task numbers to aircraft line number and AD and SB incorporation, and part numbers.

It is technically possible to convert paper and PDF cards into SGML or XML format. "However, it is not that effective," says Larson. "The OEMs have to maintain a persistent identification (ID) number to a specific task card. These ID numbers exist in SGML/XML cards, and they remain the same when revisions are issued. There are no ID numbers in PDF documents, so they have to be created during the conversion to SGML/XML."

Paper cards also have to be manually keyed into a system when converting them to SGML/XML. "Specialist providers can do this, but there are quality assurance issues," says Snow. "With data being manually entered there are naturally errors. PDF documents can be scanned, and they have electronic text that can be searched. These can provide most of the benefits of intelligent data. Once a document has been scanned, our Enigma system can make the document act like SGML because the text is OCR-readable. Parts of the text can be made intelligent so that links can be formed."

Despite the advantages of intelligent



InfoTrust's CMS system converts all content to XML. This has several advantages. One of these is that MROs should be able to generate job & task cards for a variety of customers faster than their current systems.

data in aircraft documents and manuals, some of them are still in PDF format rather than SGML/XML. "This is because not all the manufacturers that supply parts and systems to aircraft and engines provide documents for their products in SGML/XML," explains Snow. "Modern aircraft types can still have 30% of the documentation supplied as pdf, and the rest as SGML/XML. In the case of legacy aircraft, about 70% will be in .PDF, and 30% in SGML/XML. The A380, for example, has only 30% of its documentation in SGML/XML."

Airlines & MROs

Even with intelligent data, there are still several practical problems, especially in the case of cards generated by MROs.

Airlines have different fields and field sizes on their job card templates. When airlines generate job and task cards in-house for their own internal use, their M&E and CMS systems will extract data from the database and manuals to populate the job and task card templates. This becomes more difficult when sub-contracting work to MROs. "The first problem is that the airline's M&E system will have specific fields and layout design for its cards, but this will be different to the MRO's job and task card template in its system," says Reed.

This is less of an issue if the MRO has regular, long-term work from the airline, since a template for the customer can be created.

The MRO faces a larger problem in that each of its customers has a different routine card style, layout and design format, and also card and work order numbering systems.

"The bigger issue is that few airlines or MROs have the full IT system ability to pass intelligent data between each other, and for the recipient to generate cards electronically with the data it gets," says Kaponeridis. "The first step to this would be for airlines to have a M&E system interfaced with a CMS, and MROs to at least have a standalone CMS to electronically generate the cards.

"While there are standards for 'parts transactions' (Spec 2000) and for digital document content interchange (S1000D, iSpec2200), there are no comprehensive 'data interchange standards' to move a set of SGML/XML data from one M&E plus a CMS to another, for example from an airline to an MRO that has a different system," adds Kaponeridis. "The fact that both parties use SQL or XML has nothing to do with interchangeability. The complete transactions need to be defined and used. XML can play a great role in this, but the solution always requires in-depth knowledge about the systems at both ends. One solution would be to have 'exactly' the same systems at both airline and the MRO. However, this is impractical due to the different needs of these two types of organisations."

An interchange of data between two different systems requires specialist or customised software and processes so that data received by the recipient are converted into a format that its own system can use. The data from the other party's system is structured differently. These customised interfaces must be regularly updated as either end of the 'data exchange pipe' changes over time.

These issues have to be addressed if the MRO is considering accepting data electronically from its customers for the purpose of generating cards.

Another possible method is if the airline or lessor subscribes to the premium services provided by the OEMs, so that the data is sent to the MRO in SGML or XML format. The MRO still needs a system that can handle this data. "The process requires a human interface because of issues of applicability for individual aircraft that have to be handled manually," says Buzun.

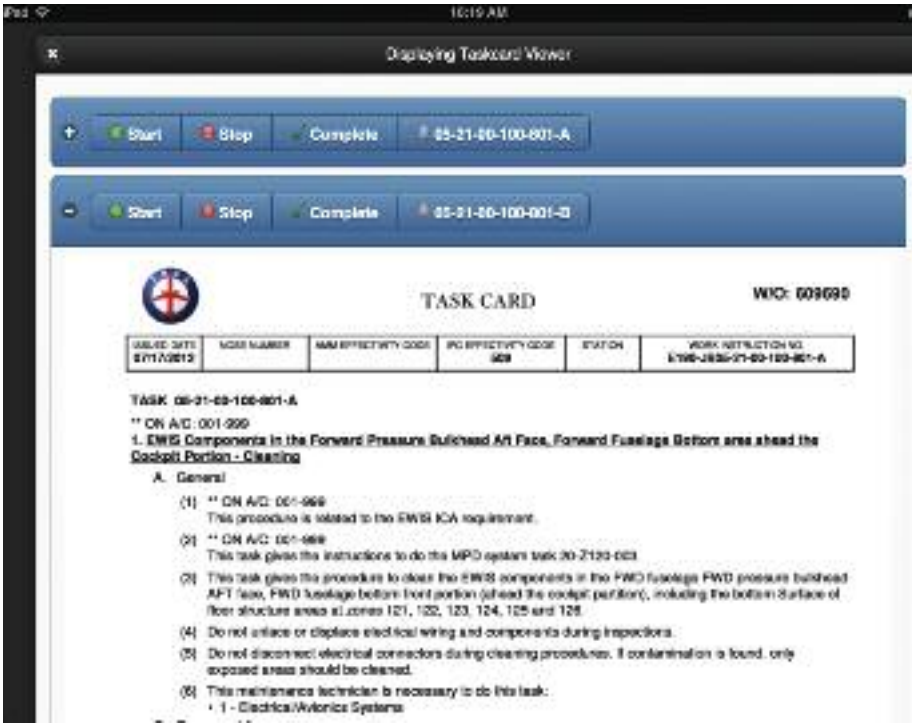
If two parties have configured a system for passing intelligent data between each other, then the problem of a lack of an international standard for a job and task card style, layout and format can be circumvented. This is because SGML provides intelligent data and also has DTD information to assist with card layout and design, and XML data is purely content and does not have layout and design properties. "This means that style sheets and different layouts or designs can be done in any way required when using XML data," says Michael Denis, vice president of consulting at InfoTrust. "It should therefore be easier for MROs to cope with the different job and task card layouts and designs that each of its customers have. Pure data could be sent to the MRO and imported into any job and task card template.

"If MROs could receive electronic or intelligent data, they would realise multiple benefits, including faster card preparation," continues Denis. "The advantage of electronically-generated task cards is that the links in the intelligent data mean that labour, tools and parts can be prepared in advance. This means a check can be pre-flowed in terms of its job card sequence, with a list of all the tools and parts prepared in advance for each day. Moreover, 60-70% of non-routines that occur in base checks are predictable, so many airlines will have these in their M&E and CMS systems. Planning all of these issues means the progress of a check can be tightened, so a lot of MROs could improve their labour productivity. For example, the downtime for a heavy base check on a widebody could be shortened by 15-20%."

E-cards & digital signature

Signing off cards electronically via a computer terminal and informing the M&E system that a task has been completed, while manually signing the printed paper cards, increases the number of tasks to generate technical records.

A preferable system would be to send



Air Canada Jazz uses Trax, and its Trax doc module to convert PDF and SGML manuals into XML format, prior to editing and task card production. Air Canada Jazz also sends the electronic cards to computers, and will use iPads for use by mechanics in base maintenance.

electronic cards from the M&E and CMS system to computer terminals or remote computer devices for use by mechanics. These are then signed electronically, and no paper or scanning is required.

The two major obstacles to an airline achieving digital signature status are lack of regulatory approval, and lack of hardware and infrastructure.

Ramco has one of the earliest systems of fully electronic signature. "We have had a system approved since 2005, for a customer with no electronic content for documents and manuals," says Jerry Magin, senior director for Aviation and Enterprise solutions at Ramco. "The data and manuals in the user's system are a precursor to PDF, and are held on CD-ROMs or as PDF documents on another system.

"The job card is created in Ramco, but the actual item is just a summary of the task," continues Magin. "The card in Ramco has a summary of the task to be performed and references to the particular pages of the AMM and other manuals. Some of these references are made with hyperlinks to the manuals. A complete job card with all the detailed steps is therefore not actually created."

The mechanic accessing the job card in Ramco at a computer terminal in the hangar will refer to the various manuals, and access them to get the detailed steps they need to complete the task. In some cases these are accessed by clicking on the links in the job card. "These relevant pages in the manuals can be viewed on screen or printed off. Once the task is completed, the mechanic can sign off electronically without the need to keep paper records," says Magin. "To get approval for this, the card system has to prove that the reference in the job card is to the correct version of the manuals stored as pdfs or CD-ROMs. These pages can change when revisions are issued by the OEMs, so the reference has to be to the latest approved version. Changing the references in the job cards is a manual process each time revisions and updates are issued by the OEM. New references then have to be created electronically. It allows a fully electronic system, and works for an operator that does not have data in SGML, or that operates a M&E system that cannot manage SGML."

Fully electronic

While there are now an increasing number of airlines that can manage data in SGML/XML and generate cards electronically, few then send cards to remote devices or computers for use by mechanics for their own internal maintenance activities or sign-off electronically without the use of paper. There are some exceptions to this, and the number of airlines using a fully electronic, paperless system is growing.

First, data has to be held in PDF, SGML or XML, and the airline has to have the right capability on its M&E and CMS systems to generate the cards.

There are several stages to go through to achieve a fully electronic system, since all airlines use a large number of maintenance facilities for all line, base and component maintenance. The cost of establishing sufficient capabilities can be too expensive for many airlines. "Digital signature and a fully electronic and paperless system still make sense," says Snow. "This is because there are short delays between tasks being done and the M&E system being informed of task completion. It also removes a lot of steps in the traditional or electronic signature processes, which will save overheads in the long-term. It does require high upfront investment. A halfway solution at some line stations is to send them cards electronically, and then print them out."

To completely understand the process, it needs to be viewed in reverse. "The objective is to have task cards presented on a computer or mobile device. This requires it to have HTML capability or a specific operating system application that allows the user to view the cards via an internet browser," says Larson. "Data in SGML or XML will work for these."

Enigma's system takes e-task cards and renders them in PDF. These are then turned into an electronic card, and additional fields are added. "The Enigma system creates pale blue fields so that data and information relating aircraft registration, work order number and other details can be autopopulated," says Snow. "The sign-off boxes for mechanic and inspector are also shown in blue, and these are used for the digital signatures. The mechanic can type and record findings in a big summary box at the end. A large portion of documents and manuals for most aircraft types are still in PDF, not in SGML/XML. However, electronic cards can still be generated."

InfoTrust's system converts all documentation to XML, prior to rendering cards in HTML. "XML is the most likely data format to feed either a HTML or specific operating system," says Larson. "The cards can be rendered in pdf, provided a digital signature can be applied to it."

Air Canada Jazz & iPads

Air Canada Jazz uses Trax's doc module to convert documents and manuals into XML prior to editing. "We operate 137 aircraft. The modern types are the Q400 and CRJ-705, and their documentation is supplied by Bombardier in SGML," says John Hensel, manager of business services portfolio for maintenance at Air Canada Jazz. "Our older types are the Dash 8 and CRJ-200, and documents for these are supplied in PDF. The PDF files are loaded into Trax, and we edit these by adding some of our own content on a template and then a PDF of the card as a reference for the mechanics. This is manual, so we get

Air Canada Jazz has been using a fully electronic task card production and on-screen signature since 2010. The airline has found it easier to audit technical records, errors are easier to spot, and the error rate has dropped to about 1%.

more errors than with the younger types in SGML.

"We convert to XML because it is just content, and we can build style and layouts in Trax as we require," continues Hensel. "Cards for all types are rendered in HTML and then sent to computers in the hangar or remote devices."

Air Canada Jazz is introducing iPads for line mechanics to view and sign off cards in line and base maintenance. "Each mechanic will have a tablet. Tech logs are still kept on paper, but we will later use the iPads as electronic technical logs (ETLs), and dispose of paper," says Hensel. "We use 10-12 fixed terminals in the hangar for line maintenance. Tasks can be viewed and signed off electronically. We have had electronic sign-off for two years, and had to use paper and electronic sign-off in parallel for two months to satisfy the regulatory authorities.

"Lessors still want paper cards for things such as ADs, SBs and repairs, so about 8% of cards in heavy checks are still paper," continues Hensel. "Where new leases are being signed, however, the lessors are allowing 100% electronic cards and signature."

Air Canada Jazz has trialled Panasonic toughbook tablets, and Trax created an HTML 5 web application to view cards in base maintenance. "We will switch to iPads simply because they are cheaper than the Panasonic tablets," says Hensel. "The iPads come with rubber covers and a plastic coating, which is resistant to fluids such as skydrol. In the several months that we have been using iPads we have not had one damaged or broken.

"We find that maintenance and technical records are far better than when we used paper cards," continues Hensel, "because it is far easier to track things such as mechanic licence expiry and compliance. Paper records have a high level of discrepancies, such as the number on a non-routine card not being linked with the routine card that originated it. The electronic system highlights these discrepancies in red, so technical records can be audited for problems very quickly. We have halved the number of people in technical records, and have got our error rate down to 1%. The errors we do get are usually associated with the few paper records that we have to keep."

Check progress & SFDC

SFDC has been available for use with M&E systems for as long as electronic signature. SFDC applies barcodes to job cards. These are scanned by mechanics at the start and end of the work to measure the MH used to finish the task. The use of parts and materials for the task is also recorded this way *(see Technology for SFDC & paperless maintenance, Aircraft Commerce, December 2011/January 2012, page 46)*. Consumption of MH and materials is recorded in the M&E system.

Another benefit of scanning cards at the start and end of each task is that the progress of each task and the whole workpackage can be monitored by the M&E system. The non-routine cards can be associated with particular routine cards, and the inputs and ratio of routine to non-routine for each card and groups of inspections or types of inspection can be monitored.

SFDC is done when line mechanics swipe job cards with a handheld barcode reader at the start, and then again at the end. These handheld readers also require wireless routers to communicate with the M&E and CMS systems. They can also be used to connect the M&E system with handheld devices like tablet computers, which can be used to view electronic task cards, and also allow digital signature.

The time spent by mechanics leaving the aircraft to swipe a job card at task completion, and also at the start, adds a few minutes to each job card.

"Ramco has developed a checking screen that can be used by the mechanic to clock in and out of a task. We have extended its use so that a task can be signed for electronically," says Magin. "The screen allows the mechanic to view the job and task cards. The screen is now capable of SFDC in real-time, so we get very accurate SFDC, and an audit of the check can be made in real-time."

Another time-consuming process was the manual writing of non-routine cards following hand-written findings on task cards from mechanics. An element of non-routine card generation was mechanics typing in non-routine findings to the M&E system, or handwritten findings on the cards being entered into the M&E system by clerks.

Using digital signature means the start and completion of a job card will automatically be recorded by the M&E system. Eliminating the need to swipe cards, as well as walk between the aircraft and computer kiosks will save several minutes per job card. "The use of electronic cards and digital signature should mean that the MH and material inputs are recorded more accurately," says Snow. "It should be easier to keep abreast of job card completion, and to obtain more granular SFDC data."

Other technologies improve the monitoring of checks, and involve the use of tablet computers to send cards to mechanics. EmpowerMX has developed a Fleetcycle Production Manager system to manage checks on tablets. The system allows mechanics to inform inspectors and production control engineers of findings. Non-routine cards can be generated on the tablets. The card can include pages from the relevant manuals which are held in the CMS, and accessed via the tablet. AC