Documentation technology has advanced in recent years. The authoring standard for aircraft documents has changed to S1000D, while systems have become available to convert all types of documents into a single format.

Recent advances in documentation technology

Technology that makes it easier to manage technical documents continues to be developed. Despite the advances of recent years, no airline has a documentation system that is 100% electronic, as this is still logistically difficult even for an airline with the most advanced system in place. Many airlines are still managing all their documents manually, even though there are obvious savings in time and cost to having an electronic system.

Document types

Documents fall into two categories: reference material from original equipment manufacturers (OEMs), to allow the operation and management of aircraft; and all various types of maintenance records.

Reference manuals start with the maintenance planning document (MPD) for each aircraft type, and all its successive revisions, issued by the OEM. Each airline's maintenance programme is derived from the MPD, the maintenance review board (MRB) report, and the aircraft's component and rotable configuration and time limits as delivered by the OEM when new.

For on-going operations, several manuals are required: the aircraft maintenance manual (AMM); illustrated parts catalogue (IPC); fault isolation manual (FIM) or troubleshooting manual (TSM); job card instruction (JIC) manual; aircraft wiring manual (AWM or WDM); structural repair manual (SRM); ramp maintenance manual (RMM); the system schematics manual (SSM); and service bulletins (SBs) and airworthiness directives (ADs) issued by the aircraft, engine or component manufacturer and the Federal Aviation Administration (FAA) or European Aviation Safety Agency (EASA).

Maintenance records and management documents are those generated by airlines, operators and repair organisations, some of which originate from the OEM. Starting with the maintenance programme, job cards are collated with relevant pages from the AMM, IPC and other reference manuals.

Once job cards have been utilised for instruction and are signed by mechanics and technicians, they are retained and stored in the form of maintenance records, creating thousands of pages of paper records over the operational life of the aircraft. These have to be searched and analysed in the event of accidents, or in the event that the aircraft changes operator or country of registration or, in some cases, is bridged onto a different maintenance programme. Missing or irretrievable records mean that maintenance tasks must be carried out again, often at a high cost.

Several other types of document arise from the operation of aircraft, including: Engineering Orders and Authorisations for repairs and aircraft modifications; rotable component tear-down reports; airworthiness tags and documents; technical/maintenance logs; pilot reports (PIREPs); and non-routine cards.

Airlines also have to keep records of purchase orders, repair orders, receipts of goods, documents related to the shipping of parts and components, training and personnel records, maintenance vendor and facility certification, and management reports.

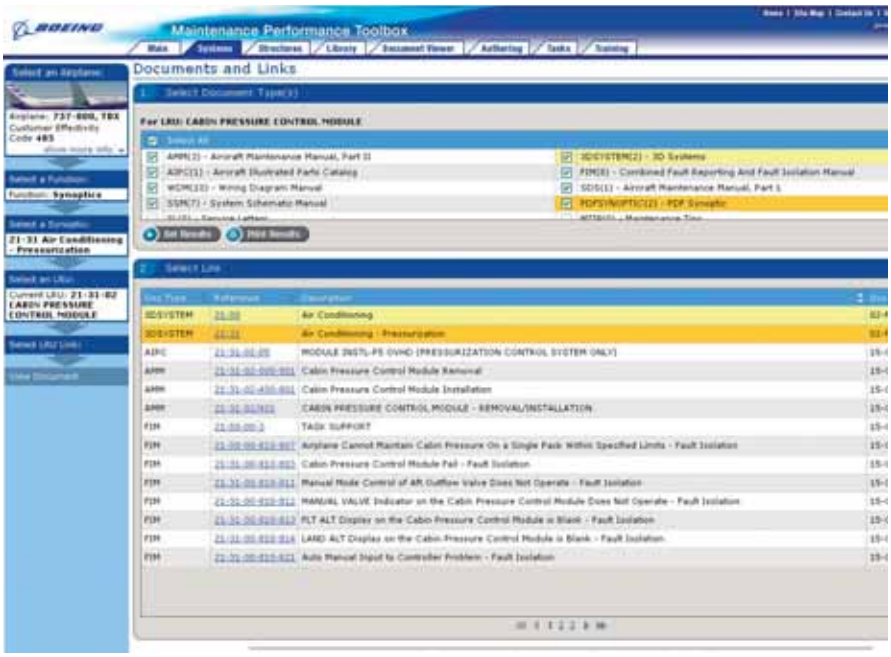
Documents in use

A set of reference manuals for a single aircraft type totals several thousand pages, and several sets may be required across an airline's operation. Airline engineering and technical publications departments have libraries which must be kept up to date, and distribute the relevant copies to the relevant technical departments. As an example, all line maintenance stations would require copies of the AMM, IPC, TSM, FIM and others. Overhaul bases, which in most cases include repair shops, are all required to have up-to-date copies of various component and line replaceable unit (LRU) manuals on hand.

MPD changes can drive periodic updates and revisions to the AMM and other technical manuals which, in turn, can drive changes to the airline's approved maintenance programme. These require regulatory approval. Updates have an effect on the JIC and other manuals, and must be managed by the engineering and maintenance programme departments, which are responsible for managing an airline's technical library. All departments and technicians using the affected documents must be sent updates and instructions for archiving or disposing of the old versions. Technicians and mechanics must acknowledge receipt of updates to their manuals. These updates and changes throughout an airline's operation must be monitored, managed and audited. Implementing an update and receiving acknowledgements from all concerned can take several weeks using a traditional paper system.

Moreover, certain instructions and procedures in the AMM and other manuals, and particular parts in the IPC only apply to certain aircraft line numbers. These are noted by engineers writing job cards, which is time-consuming under a traditional paper system. Mechanics and technicians also have to look for and order particular parts. Managing these changes manually therefore creates a large volume of paper, and requires a large number of engineers, authors and approvers.

Electronic systems mean that the management, distribution and updating processes can be simplified, which saves time and expense. Updating and the associated audit trail, for example, can be completed largely automatically in a matter of hours versus several days.



Boeing's MPT has a tree structure for users to locate relevant manuals amd troubleshoot particular faults.

Documents can be made available on-line to technicians and mechanics almost instantly. Another improvement is that technicians and mechanics do not have to spend a lot of time searching printed manuals for instructions and parts catalogues. With the right equipment and technology, relevant pages can be found within seconds, and viewed on screen. Mechanics also make fewer mistakes, and always have access to the most current approved technical information.

Electronic content evolution

Document evolution has developed in two parallel streams. These are the standards in which documents are written, and the format with which they are made available.

In 1956, with the development of the first jet aircraft, aircraft documents were written in a standard according to air transport association (ATA) specification 100. "This was later upgraded to ATA Spec 2100 in 1994, and the two were then consolidated into ATA iSpec 2200 in 2000. The 777 was the first to use ATA Spec 2100, which has since been the industry standard for writing and authoring aircraft documents," explains Geoffrey Godet, chief executive officer at InfoTrust Group. "The standard for European defence manufacturers was S1000D, and manufacturers are making documents available to airlines in S1000D. The A350's reference manuals are written in S1000D standard. The reference manuals for the 787, A350 and Bombardier C Series will also be written in S1000D. ATA iSpec 2200 may still continue to be used."

In parallel, there have been various standards of technology and formats for presenting the documentation. With the advent of electronic documentation, standard generalised mark-up language (SGML) was used. It was first introduced in 1993-1994, and was used by Boeing for the 777 as this was being introduced. Boeing also used this standard to retrofit some of its older types. Bombardier and Airbus then started to use SGML. The web page www.boeing.com/commercial/ams/digital/doc_availability.html lists the Boeing and MDC types, and whether their references are in SGML format.

Documentation at the time was delivered by OEMs to airlines in CD and portable document format (PDF), but a few years later the internet evolved as a faster form of distributing and retrieving documentation. This allowed documents to be written in a new format.

The ATA iSpec 2200 and S1000D writing standards required documents to be written in SGML format. SGML is a system of providing intelligence to an electronic document, rather than just plain text in a traditional paper document. Part of ATA iSpec 2200 is having an intelligent format for writing manuals and documents. ATA iSpec 2200 defined SGML for more than 15 core aircraft maintenance-related documents. This provides an organisational structure, while semantic tagging for part numbers and tools adds intelligence to the data.

A paper document in the AMM, for example, will give instruction A to perform a maintenance task if a particular SB has been completed, or instruction B if the SB has not been completed. It is then up to the mechanic to decide which instruction to follow by determining if the SB has been completed. Using SGML, however, an intelligent document will be written for a particular aircraft line number. By communicating with other systems and documents electronically, only the applicable and effective technical information will be provided to complete the maintenance task.

SGML has more recently been followed by extensible mark-up language (XML) format. This is a more advanced system of writing intelligent documents.

The latest standard of aircraft reference documentation is written in the S1000D standard using the XML format. S1000D not only defines the writing standard, but also how data relate to each other, and are communicated between suppliers, the OEM and the operators.

While SGML documents and manuals written in the SGML standard can be converted to XML, it is also possible to convert ATA iSpec 2200 manuals to S1000D standard manuals, as Delta Airlines is doing.

The reference technical manuals and documents of aircraft, components and engines that have entered service since 1956, are written in a range of formats. "Airlines receive reference manuals for engines and components direct from the manufacturers. For the older types these may still be in paper and PDF format, while for the newest types these will be in S1000D format," explains Godet. "Moreover, the reference manuals for the airframe, components and engines of an aircraft are often provided in different formats. Airlines with mixed fleets, for example, receive documentation in several formats. A 787 configured with certain engine models and rotable component part numbers could have documents provided in S1000D, ATA Spec 2200 and PDF, SGML and XML."

OEM documentation

With the development of the internet as the main delivery tool for documents, and the advent of SGML/XML language for writing documents, the OEMs could promptly deliver intelligent documents and regular updates direct to airlines.

The range of OEM reference manuals and documents has been described. All major airframe manufacturers provide reference manuals electronically, and have complete services to update them, and for airlines to manage their documents.

Boeing

Boeing offers an integrated suite of hosted applications through the website www.myboeingfleet.com. This provides

maintenance information for a range of Boeing and McDonnell Douglas (MDC) aircraft, including all commercial types. The service comprises the maintenance performance toolbox (MPT), which allows airline users to quickly find the information they want. "There are seven groups of documents in the MPT," explains Larry Little, programme manager of MPT at Boeing. "The first is intelligent documents, written in SGML. These cover the 737-300/-400/-500 family, the 737NG, 757, 767, 777, 747-400 and 747-8. The 787 is the first Boeing aircraft whose reference manuals are written in XML. Older Boeing and MDC aircraft are excluded, although the reference manuals for the MD-90 and MD-11 will be available in SGML in the future. This service provides customers specific reference manuals in SGML and XML format, and includes a revision service in the price. Aircraft types that are not supported with documents in SGML and XML are supported by PDF documents.

"The second group is multimedia. This has 3-D pictures which are useful for finding parts, and also provides animation of how repairs are made, and how components are removed, disassembled, assembled and installed. Another feature that Boeing has developed is quickly finding approved structural repairs that have already been developed by zooming in on a 3-D animation of the aircraft," continues Little. "The third group is an airline's own documents. An airline will need to keep and maintain its own maintenance programme, repair structures, reliability data and other documents. Our hosted service means that airlines do not have to store their own documents. The fourth group comprises repair records. This keeps a record of approved repairs that can be referred to in the future whenever they are required. The fifth group contains non-XML files for older aircraft types, engines and components.

"The sixth group is supplier data, comprising reference documents and manuals for components and engines equipped on the aircraft. This is a new service for the 787, so it is only offered for this type," explains Little. "The service is not offered for the 747-8."

"Each of these groups is accessed via a tab on www.myboeingfleet.com," adds Little. "There are also authoring and data manager tabs. The authoring tab gives airline engineers the ability revise or modify the SGML and XML documents. Examples are modifications to maintenance tasks and repairs. Airlines may also add their own supplemental type certificates (STCs). The data manager tab is an administration tool that allows airlines to manage revisions as they occur, and keep track of them."

Airbus

Airbus has a web portal service called Airbus World for Airbus operators to find and download reference manuals, and to store their own manuals and documents.

Reference documents for the A300 and A310 are provided by Airbus in enhanced PDF format. All other types are written in SGML and XML. Documents for the engines and components are provided direct from the relevant suppliers. The reference manuals for the aircraft are written in ATA Spec 2200 for the A300-600, A310, A320 family, A330/340 and A380. Manuals for the A350 will be written in S1000D format.

Airbus introduced 3-D pictures for parts and other illustrations, and animation for task cards where required for the A380 for the first time. This will also be available for the A350. A possible future development for the A350 will be the integration and synchronisation of the airframe, engine and component documents.

Airbus World comes in several modules. The prime module is AirN@v, which provides all reference manuals electronically and the browser capability for viewing them.

AIRMAN is a real-time health monitoring and troubleshooting system integrated with the relevant manuals in AirN@v. AIRMAN receives messages from the aircraft in-flight and on the ground. There is also wireless communication between the aircraft, AIRMAN, AirN@v, ADOC, the airline's maintenance IT system and the eLogbook, which is a system used by flightcrews to write the log of each flight, including PIREPS and technical problems.

ADOC is a facility for customising Airbus's documents to an airline's own operation. Reference manuals are regularly updated, and different updates apply to different airlines and aircraft line numbers. If an airline changes the configuration of one of its aircraft through a modification or SB, and customises a maintenance task, it informs Airbus of these changes. The reference manuals that relate to the operator and line number are updated with the relevant change by Airbus, since each airline has its own set of documents and manuals in the Airbus World portal.

All these changes are tracked by Airbus. Changes to the airline's own customised AMM, for example, also have to be made to the master AMM held by Airbus, which must then be downloaded by the airline, so that the changes are reflected in both documents. The ADOC facility in Airbus World carries out the regular customisation of an airline's documents, and synchronises changes with the master reference manuals, providing a revision management capability.

Another module of Airbus World is AirPl@n. This provides a suite of services for maintenance planning, including the optimisation of the maintenance programme and maintenance planning to fit with the airline's operation. It also helps with maintenance interval escalation. The effect of escalating certain tasks or checks, or equalising checks into smaller groups of tasks can be simulated prior to actual escalation.

Practical use

The Boeing system has five modules for airline users. The first has manuals and documents related to aircraft systems, for example troubleshooting problems with the aircraft's electrics and avionics. The second module relates to aircraft structures, and allows mechanics and technicians to find repairs and tasks. This module also includes a decision tool, which helps engineers find correct structural repairs, but this is only available for the 787. The third module is for training, and shows airlines how to build training sessions for mechanics and technicians using the latest Boeing documents.

The fourth module is for locating parts, and is for the 787 only. It provides the IPC in a 3-D format. This allows users to view parts and structures from all angles, as well as remove parts from assemblies to see what things look like.

The fifth module is for tasks, and is used to locate tasks, manage maintenance planning, and write task cards.

The MPT has various functionalities that can be used by mechanics and technicians. During operation a technical fault will arise. This may be provided in the form of a fault code on the aircraft's central maintenance computer, or in the pilot's report or aircraft technical log as written by the pilots. Taking a problem with a pressure release shut-off valve (PRSOV) as an example, a mechanic can look up the PRSOV under the ATA Chapter for pneumatics in MPT under the systems section, and then do a Table of Content look-up in the library. With a click the user can get all the relevant documents and links to the PRSOV from a search of the entire library. In the AMM, for example, that would be all the

relevant pages relating to fixes, removal and installation. SGML documents allow revisions between related documents to be made easily. That is, a change in a maintenance procedure may also be related to a change in a part number in the IPC. Moreover, parts that are relevant to particular aircraft tail numbers are only listed. Part numbers not relevant to a tail number are clearly hashed out so that mechanics do not make the mistake of using them. The MPT's animation tab also means there can be visual instructions for testing, fixing, removing and installing parts. These are shown by clicking on the relevant SGML/XML reference.

Senior engineers in an airline are authorised to edit documents and reference pages in SGML/XML via the edit button on MPT.

The multimedia group of documents in MPT can zoom in on a picture of the aircraft to find if a particular structural repair already exists. For example, zooming in on the vertical stabiliser on the relevant aircraft type will reveal coloured dots or squares where approved repair schemes already exist. Clicking on the dot or square will show all the relevant information on that repair in the SRM. The description of the repair will also have various attachments, including the approval from the airline's local authority, photographs of the damage, and the part numbers used to make the repair.

Airbus World has a similar system for airline users to work through. The home page has five modules. The first is Customisation & Delivery, which relates to the aircraft's configuration at delivery to the airline.

The second is Training, so that Airbus and airlines can train mechanics and operations staff. The third module is Flight Operations, and is not related to maintenance & engineering activities.

The fourth module is Maintenance & Engineering. In this module, the user has five main choices, each with several sub-choices under it. The five main choices are Manage Fleet, Perform Engineering Activities, Modify & Upgrade, Prepare Maintenance, and Do Maintenance.

The sub-choices under Manage Fleet are: Get my fleet status; Monitor my fleet; Analyse reliability, which relates to airline reliability statistics; Optimise my fleet; Optimise maintenance costs; and Manage fleet issues. 'Optimise my fleet' recommends modifications and upgrades, SBs and optional improvements. It also lists all the modifications made so far for each aircraft type. The full details for each are obtained by drilling down, and there are links to the associated SB.

'Optimise maintenance costs' relates to benchmarking maintenance costs to help an airline optimise them.

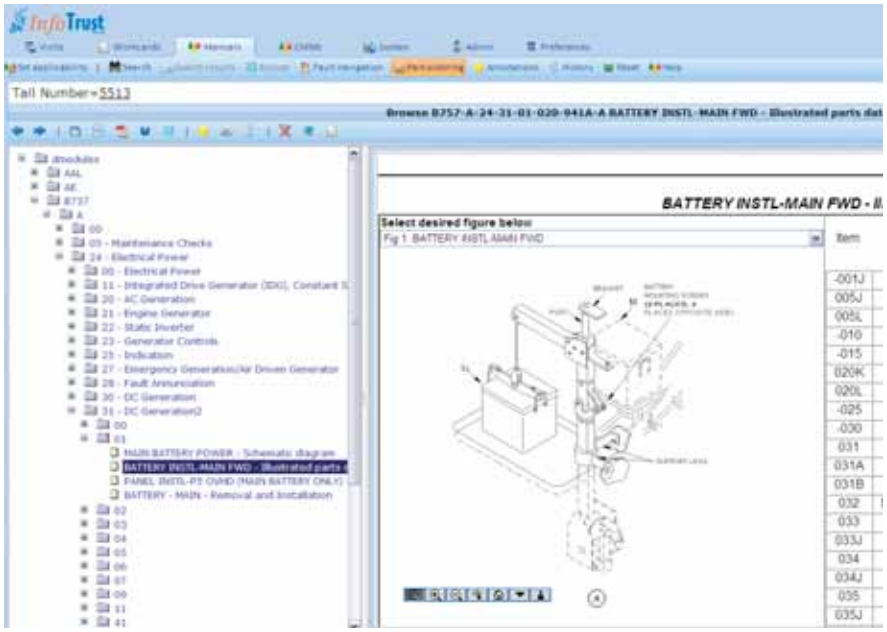
The fifth module is Material Management, containing six choices: Planning; Procure Spares and Kits; Inventory & Logistics; Repair & Overhaul Spares; Supplier Management; and Warranty Administration.

The system also has a word search facility for dealing with a problem. The user can also type in ECAM (Electronic Centralised Aircraft Monitor) messages to get all the relevant documents that relate to a problem. There is also animation for the A380, and later for the A350, to show how to fix problems and to locate structural repairs.

Third-party reference manuals

It remains a problem that documents for a variety of aircraft in mixed fleets and of different vintages come in a range of formats and authoring standards, and require several viewers. This issue has led to third-party providers that offer reference manuals for a wide range of aircraft, engine and component types in a single format and authoring standard that can be accessed through a single viewer.

InfoTrust is the market leader in providing such third-party services. "In addition to mixed vintages, models and makes of aircraft, aircraft also get leased,



InfoTrust is a system that converts all documents and reference manuals into the same format by using an advanced rules-based engine. Delta Airlines is the first carrier in the world to have a system that will manage all its documents in a single format.

sold and reconfigured at a relatively high rate," explains Godet. "The requirements for airlines are therefore frequently changing, so they need a universal viewer to operate across all aircraft manufacturers, aircraft types, authoring languages and various levels of technology. The variation in different standards is illustrated by the fact that old types like the 727, which have paper documents written in ATA Spec 100, are still in operation. Other types of a similar age will continue to operate for many more years in the case of some freight carriers. Later-vintage aircraft have documents written in ATA iSpec 2200, and are either in paper, PDF or SGML format. The very latest are in S1000D standard and XML format. InfoTrust is the only system that converts all documents and reference manuals into the same format by utilising an advanced rules-based engine. Documents for the A320, 757, A350 or 787, and their components and engines, for example, that come in S1000D, ATA or PDF format, will be available in the same format and spec with our unique system. Delta Airlines is the first airline in the world to have a system that will allow it to manage its content in a single format, regardless of whether it was originally issued in ATA iSpec 2200 or S1000D."

Airlines also modify their aircraft and their reference manuals and documents. At the same time, OEMs update their reference manuals every three to four months. These changes must be passed to airline libraries, which in turn must synchronise the airline and OEM changes before sending them to their mechanics so they operate with the latest information.

InfoTrust provides a back-office solution to adapt the contents of OEM and airline manuals and documents. "We provide software and services to make and manage these updates. We have also developed applications to support and manage engineering documents such as EAs, EOs, SBs, ADs and the associated maintenance programme itself," says Godet. "Airlines normally modify the content of these publications through the use of our software tools. Through integration to an MRO or Planning System, the complete check or workscope can be packaged and delivered including all applicable task cards, panel cards, engineering modification paperwork and non-routine items. Task cards are a mixture of information from different reference manuals and systems. Our system allows these task cards to be linked and brought together on the fly for all applicable tail number and check type. Our system technology fully supports an approved electronic task card capability including the so called 'dirty fingerprint' traceability regulatory requirement. Our system allows an airline's manuals and documents to be created, updated and distributed in a single format, because of SGML and XML authoring language."

Once manuals and documents are loaded into InfoTrust's system, mechanics can search using aircraft registrations or line numbers, ATA Chapters or key words to view the documents. The system will then return all relevant documents that relate to that aircraft tail number or ATA Chapter number. The unique search feature can include all aircraft manuals, component manuals, engine manuals and applicable task cards, and company procedure manuals (GMM), providing the technician with a complete list of information required to finish the task.

Mechanics can also use the system to troubleshoot technical problems with a fault code or message from the aircraft's central maintenance computer. The system allows the user to go through the troubleshooting process via a tree structure of analysis steps.

InfoTrust's system also allows maintenance supervisors to view and print the planned maintenance checks for their area or location. Using integration back to an MRO system, a list of task cards, parts, tools and drawings for each planned check can be easily accessed to facilitate crew shift-planning functions.

MRO IT systems

Airlines now have some level of MRO IT system, from full ERP systems, to pure play systems, and to the simplest point solutions. Irrespective of their complexity, airline MRO IT systems all use reference manuals and documents. They also have to plan maintenance and create job cards, and some also store maintenance records.

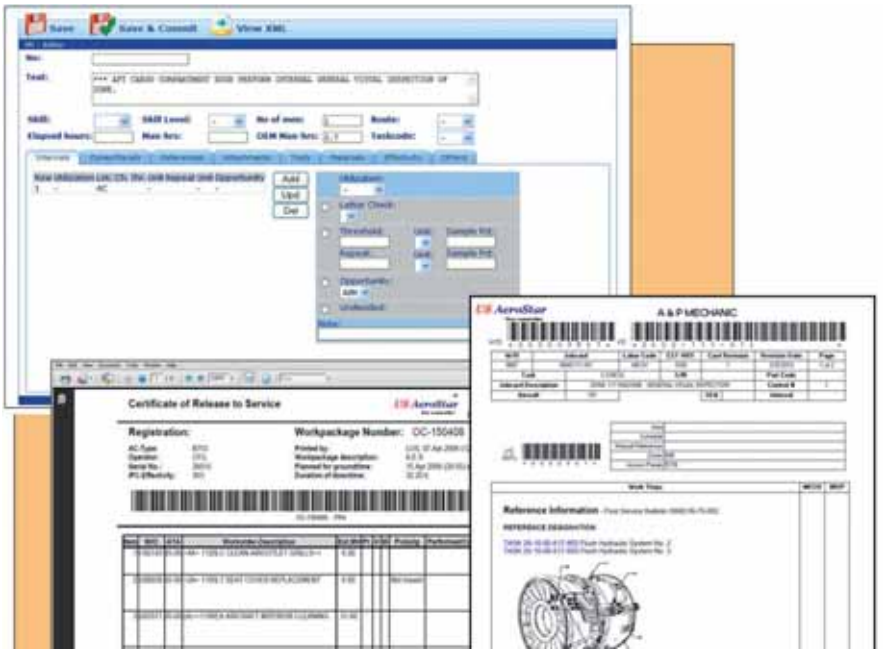
Document management involves OEMs issuing technical publications and delivering them to the users, who manage and maintain the documents and manuals, create job and signing cards, and store maintenance records.

Managing manuals

MRO IT systems have several functions with respect to documentation management.

Most OEM documents are SGML files, while manuals for the latest aircraft will be in XML. Various MRO IT systems convert SGML files into XML standard. TRAX is one system. "This is done automatically after the SGML files are uploaded," says Chris Reed, managing director at TRAX. "SGML and XML files can be edited, which is good for making updates. These are then converted to PDF files, which cannot be updated, so that they can be viewed by people in the airline. TRAX and other MRO IT systems have to import data from different OEMs differently because the data and information are not in S1000D format. In the future when all documents follow this standard the files can be imported in the same way."

Other systems have similar capability. "The SAP iMRO system uses XML files, and can convert files from different OEMs and in different formats into XML files, whatever the vintage of aircraft," says Richard Minney, head of product innovation at HCL AXON. "iMRO has a mapping tool that reads files and converts the data into a set of fields. The information in the XML files is tagged,



DigoDOC generates full engineered tasks (FET) by successfully delivery the maintenance plan in the most effective manner. This being achieved by having the materials, tools and information resources.

and the mapping tool interprets the tags. Once the files have been mapped and the XML files have been uploaded, the information goes into the database with references to the OEM's system."

Swiss-AS's AMOS uploads OEM documents in their native format and leaves them in their original state. "AMOS has a viewer which can display all types of document formats," explains Ronald Schaeuffele, chief executive officer at Swiss Aviation Software Ltd.

Aerosoft's content management system DigiDOC provides a different approach, by providing a tool to convert all uploaded SGML files into XML as standard. "XML is simpler than SGML but it offers most of the power of SGML, since it is also a metalanguage. Although there were no OEM manuals in XML prior to S1000D, XML is a more sophisticated format," explains Roger Sixto, director of support and projects at Aerosoft. "The value of this technology is in the ability to automatically produce 'fully engineered task (FET) cards' developed from the MPD, AMM and IPC manuals and containing all the work instructions, graphics, required skills and part information. This means that content changes propagate to all the inter-related documents, thereby avoiding the need to update all the documents individually. Sometimes the inter-relation of OEM data is less than perfect, and it must be fixed by the operator."

Once manuals have been uploaded into an airline's MRO IT system, they must be managed with respect to updates. "Electronic updates can be imported very quickly," explains Reed. "As with a traditional paper system, these updates must be approved by airline engineers, which still takes several days. Once approved they can be sent instantly to all relevant departments, mechanics and technicians. The acknowledgment of these updates still has to be sent back by all relevant parties for a full audit to be completed, but this whole process now takes days, whereas it used to take several weeks with a traditional paper system. TRAX compares original and updated documents side-by-side so that engineers can check them and approve the changes.

"The AMM that is uploaded into an airline's library has to be approved by engineers," continues Reed. "The approved version is then uploaded into the live system that is used by the mechanics. The old version of the AMM is archived, and TRAX keeps a list of revisions and updates. Different versions of the AMM, and other manuals, apply to different line numbers of the aircraft."

An MRO IT system has to perform several other functions with respect to updating and managing manuals. "AMOS cross-checks manuals, so that when a new updated version of a manual is loaded into AMOS a workflow is started to replace the currently used version with the new version. The system also knows when to start using the new version and archive the previous one," says Schaeuffele. "Another function is that links between AMOS-related documents and the manuals must be maintained. If there are links between an internal AMOS document (for example a job card) and a particular page from the IPC, these links may get broken when a new reference manual revision is adopted, so an engineer has to verify these affected links. A revision of a manual may also contain new pages, so links may have to be established between internal AMOS documents and the new pages. The result could be as follows: a mechanic opens a job card for which one (or more) links exist. Upon clicking on a link AMOS opens the respective document (for example a page from the IPC) where the system not only shows the content, but also offers the possibility to further click on the displayed part numbers in order to activate AMOS-related functions (such as a stock enquiry or initiating a purchase order) without having to retype the part number."

Aerosoft's DigiDOC has a 'collision analysis' functionality for comparing two subsequent versions of a reference manual. "A new version of an AMM or MPD can be uploaded, and DigiDOC will compare this with the current version on the system, and highlight the changes in the new version," says Sixto. "If the AMM is updated, certain job cards will also have to be updated. The collision analysis functionality allows the user to decide what to do. DigiDOC will automatically update all the job cards whose content was affected by the new revision, and all the links to the IPC and other reference manuals in the database. This automatic updating takes just a few hours, whereas the same process in a traditional paper system was done by a group of engineers, over several weeks or months.

Automated configuration management involves ensuring all part numbers used on a particular aircraft line number are correct, and tracking the serial numbers of parts installed on the aircraft. The first of these is achieved through links with the IPC. "Automatic configuration management also involves tracking all applicable limits, which include hard removal intervals for certain rotable components," says Sixto. "When a new version of the IPC is uploaded, the airline has to ensure that the right part numbers are being used for each aircraft line number."

Writing job cards

A key function of MRO IT systems is writing job and maintenance task cards. "These again are SGML and XML files. Each electronic job card will state the MPD revision number used for its creation, and the AMM identifies the various instructions used. These will include the part numbers, labour skill type and tools required to perform the task," says Elliott. "The task card will also have the interval, which comes from the relevant revision of the MPD. The data within the task card is all used in

maintenance planning. Maintenix automatically attaches all the instructions and relevant pages from OEM documents and manuals. The system automatically aggregates the content, and XML means this is only relevant to the specific aircraft line number and its configuration."

This automation of job and task card content is standard for most MRO IT systems. "The pages that are attached to a task card include pictures from the IPC, and even pictures of the area of the aircraft concerned or damage that has to be repaired," says Reed. "The completed task cards are sent to the assigned mechanics, who then access the electronic task cards on their laptops or computer terminals in the hangar or line station."

AMOS also displays links to other manuals and documents on the first page of a task card. These can be printed or made into a complete electronic version.

With writing and distributing electronic task cards comes the need for electronic signatures, both by the mechanic and the supervisor. This avoids the need to print paper task cards, which then need to be physically stored. Using electronic signatures means that the user has to prove that they are genuine, with one of three systems: a pin number or password for the mechanic; a type of certificate or method of identification such as a fingerprint; and a way of attaching a signature file. "The technician can log into a system and generate a signature certificate. A mechanic can use an electronic signature on a tablet computer or laptop in the hangar on the electronic task card. This signed card is converted to a PDF file, which is then stored," says Elliott.

The AMOS system uses an RFID badge for each mechanic, who also has to provide a password. AMOS checks if the person is currently valid, and if they may electronically sign the document.

Signed electronic task cards can then be sent for approval to supervisors, who can also sign electronically. "Once signed, they will be stored and archived in accordance with the regulations for electronically signed documents (typically in PDF/A format)," says Schaeuffele. "There are special regulations about storing electronically signed documents."

Electronic files can be stored and easily retrieved. Search criteria such as aircraft line number, ATA Chapter check number can all be used to find relevant pages within a few seconds.

Paper records

Despite the advances in electronic document management systems, many airlines are still generating paper records, producing tens of thousands of pages from the birth of an aircraft, making it difficult and time-consuming to retrieve specific pages or records if they are needed.

MRO IT systems are increasingly being used to generate electronic maintenance records, but this is only relevant where task cards are generated and signed electronically. Even though an airline may be able to do this internally for the maintenance it performs in-house, it will still be outsourcing maintenance to several dozen third-party providers. Unless these all generate task cards and work orders electronically, have e-signatures and electronic maintenance records, the airline will still have a large volume of paper records. Moreover, airlines still generate paper records for line maintenance that they perform at outstations, even if they have electronic maintenance records at their home bases. This is why no airline has yet achieved a 100% paperless documentation system.

There are several scanning and retrieval systems on the market. Providers include Waviatech and Avtrac in the UK, and ADS of France.

Waviatech's STREAM and Avtrac's Avdocs systems scan paper records at high speed, which can then later be read by an optical character recognition (OCR) viewer. This allows documents to be archived and searched in an orderly

manner.

Each company receives paper records daily from airlines by courier, or can visit the airline and scan its records at its home base. "We have four high-speed scanners, six medium-speed scanners and 12 portable ones, which can scan 25 pages per minute," says Tino Barry, chairman at Avtrac. Avtrac and Waviatech also have web-based services for customers that want to scan their own records.

"STREAM scans the records and converts them to tiff files, and the OCR can search for words, symbols, numbers and characters, including Chinese," explains Godfrey Ryan, director sales and marketing at Waviatech. "Several hundred pages with such a reference can be found from say 60,000 or so within about 20 seconds. Typical search criteria are AD or task card numbers.

"The system can also sort pages in date order or by other criteria," continues Ryan. "STREAM can also instantly make a page into a pdf, which can then be attached to an e-mail."

The viewer and pdf distiller make STREAM an adequate maintenance-record archiving and retrieval system. Airlines, lessors and other parties that want to view past maintenance records and acquire proof of maintenance and modifications carried out can find all relevant documents within a few seconds.

STREAM and Avdocs have similar archiving systems. Rather than just storing scanned files in order, records are archived according to a tree structure. In STREAM, files are first divided according to whether they are summary documents, or maintenance records. Summary documents are the original delivery of the aircraft. In the case of new aircraft, these include items such as the original configuration and aircraft readiness log. In the case of used aircraft they are the transition documents.

Maintenance records are divided into line checks, A checks, base checks, and other maintenance such as interior refurbishment or repainting. "Lessors and airlines often only need records from the last maintenance cycle," says Ryan. "The aircraft will have also had modifications or ADs performed prior to this, and these records need to be retrieved."

Users of Avtrac's Avdocs system have a choice of indexing. One example is searching for particular documents by aircraft registration, tail number or serial number. Scanned pages are filed under several categories, including: maintenance check records, ADs and SBs, aircraft maintenance status, airframe AD status, and modification status. Customers can define or suggest their own categories.

"STREAM archives techlog pages, and the different logbooks for the APU, airframe, engines and modifications separately," continues Ryan. "Documents can be stored in date order, by lease term, or by type of maintenance. It can also keep certificates for component changes, which come with an aircraft's configuration, to quickly determine which aircraft components do not have certification documents. STREAM also matches lessor return conditions with scanned maintenance records and the aircraft's component configuration so that any deviations can be identified.

"Another advantage of STREAM is that third-party maintenance providers can scan maintenance records as tasks are completed, and the customer can view the work as it is completed," continues Ryan. "The system can compare all barcoded planned and signed task cards so that a check's progress can be monitored. This also allows engineers or supervisors in an airline's quality department to approve or reject signed task cards while the check is still in progress, to avoid the problem of rejected task cards after completion of the check." AC