There are a large number of issues and factors for airlines that operate a diverse fleet to consider when selecting a digital technical document management system. Some of the main issues are examined.

Considerations when selecting a digital documentation system

Aircraft Commerce examined the selection of a technical document handling system in 2010. Since then, there have been many technological advances in both web-based delivery and the devices to which the information is delivered. These developments have made it easier for airlines and operators to manage technical documentation almost 100% electronically. Despite this, many still manage their documents manually, even though there a full electronic system offers process and efficiency savings.

Large numbers of software products are available for airlines, operators and commercial aviation maintenance, repair & overhaul (MRO) organisations to buy. There are also many changes taking place in the software market place. Barriers to market entry are relatively low, and software development has become inexpensive. But what should really be considered when looking for a one-stop solution for technical documentation management from more than one OEM?

Aircraft documentation

Aircraft documentation can be categorised into two main groups.

The first is original equipment manufacturer (OEM) data that allows the operation and maintenance of the aircraft. An example is the maintenance planning document (MPD), which is the main reference manual for each aircraft type, and is issued by the OEM. The operator's or airline's maintenance programme is derived from the MPD.

Day-to-day operations and forward planning require many manuals: 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); system schematics manual (SSM); and service bulletins (SBs) and airworthiness directives (ADs) issued by the OEM and regulatory authorities, such as the Federal Aviation Administration (FAA) or European Aviation Safety Agency (EASA). These are important documents that may be needed at any time during daily operations.

The second category comprises the maintenance records of the aircraft and its assets. These are documents created or collated by the airline, operator, MRO or OEM, as a record of maintenance and management of the aircraft during operation.

The maintenance programme job cards are grouped with the necessary pages from the AMM and IPC or other relevant reference manual to assist the technicians performing the maintenance.

Once the maintenance has been carried out and the necessary documentation has been completed by

Aircraft documentation originates from aircraft, engine and component manufacturers. Airframe manufacturers provide regular and premium on-line technical document management services. Premium services allow operators to customise their manuals and maintenance task cards.

the technicians, the documents must be stored as the aircraft's maintenance records. In a traditional system, this creates thousands of pages of paper records; in an electronic system, it creates many hundreds of megabytes of stored data.

These records have to be stored in a searchable manner, in case there is an accident or the aircraft is sold or changes operator. This is because due diligence and full back-to-birth traceability has to be carried out on all the major components and maintenance tasks to ensure their airworthiness. If a record of a lifed component or check is missing and irretrievable, then the maintenance must be performed again, or the component replaced at a high cost. This would be the only way the aircraft could return to service and remain airworthy.

General operation of the aircraft will generate other documentation that has to be retained. Engine shop visits, repairs and modifications to the airframe rotable components and airworthiness reports, and technical defaults occurring during operation all have to be retained, until either the aircraft is retired or rotable components are replaced.

A set of reference manuals totals thousands of pages, and several sets are used across an airline's operation. An airline's flight operations documentation library can weigh up to 50 kilos on each aircraft. If the airline has any line stations then the number of manuals has to be doubled. An airline's engineering and technical departments in the past had libraries with a full-time technical librarian to maintain and distribute the relevant copies to the technical departments. Each line station would need at least one copy of the AMM, IPC, TSM and FIM as a minimum.

Base maintenance facilities, engine shops and component repair shops are all required to have up-to-date copies of their respective component overhaul and repair manuals and LRU manuals on-site.

MPD changes can drive periodic updates and revisions to the AMM and other technical manuals that, in turn, can drive changes to the airline's approved maintenance programme. These require regulatory approval. Updates to the MPD and other manuals affect 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 changes throughout an airline's operation must be monitored, managed and audited. Implementing an update and receiving acknowledgements from all concerned used to take several weeks, if not months, using a traditional paper system.

Electronic systems

The implementation of electronic document management systems, and the true realisation of the connectivity power of the internet, means that Boeing and Airbus now no longer issue paper manuals. Their manuals are still available in off-line digital media, such as digital versatile disc (DVD), but it is rare to find an operator still using this as the main format to access technical documents.

Boeing offers MyBoeingFleet.com, and Airbus offers its Airn@v system. These password-protected portals are now the single point of customer entry into both Boeing and Airbus for maintenance, engineering and flight operations data and technical documents. Literally millions of engineering drawings, a full range of maintenance manuals, SBs, fleet statistics, flight manuals and other documents are accessible quickly via their respective portals. Updated daily, their contents give users access to the latest and most

Flatirons's TechSight/X product helps airlines create and manage flight operations and maintenance manuals. This is in XML format, and the system can be used to deliver data to tablets and other devices.

accurate information for safe and efficient fleet operations.

This has two major benefits. First, the user no longer has to keep a vast library, because as long as there is access to an internet connection, and a device with a web browser, they can access all the OEM manuals that previously had to be kept in a technical library either on paper or hard digital media. The other benefit is that it removes the need to maintain and update manuals, since the user will always be logging onto the most up-to-date version. The onus is now on the OEM to maintain and update the technical manuals. The paper footprint of the OEMs and airlines is also reduced.

Boeing and Airbus also offer maintenance and repair documents in digital format for operators that choose to create their own systems for using the data. The data is offered in extensible markup language (XML) format for the text and computer graphics metafile. Image data is provided in either consultative committee international telegraph and telephone (CCITT) or group IV tag image file format (TIFF) image for the graphics. This conforms with ATA specification 2100 for digital data interchange.

Airbus offers the data in standard generalised markup language (SGML) raw data for processing of all products covered in any of the above AirN@v modules, as applicable.

Choosing XML as the backend technology is useful for operators and M&E providers. Not only can Boeing just send the XML data to the operator electronically, but each operator is able to decide how to display or process the data according to its individual needs.

SGML is the international standard for defining descriptions of structure and content in electronic documents. XML is a simplified version of SGML; XML was designed to maintain the most useful parts of SGML. SGML requires that structured documents reference a document type definition (DTD) to be 'valid'; XML allows for 'well-formed' data and can be delivered without a DTD. XML was designed so that SGML can be delivered, as XML, over the Web.

Web browsers have supported XML for some time now, and developers have used it to deliver technical documentation products and services.

Documentation standards

In 1936 the Air Transport Association (ATA) of America was formed. It is the oldest and largest airline trade association in the US, comprising 17 members and affiliates, which transport more than 90% of US airline passengers and cargo.

The ATA standardised aircraft documentation in the mid-1950s when the air transport association created the ATA 100 standard.

ATA 100 was a paper-based system that, until the late 1980s, had no digital specification. It was a common referencing standard for all commercial aircraft documentation. This commonality enabled greater ease of learning and understanding for pilots, aircraft maintenance technicians and engineers.

ATA 100 provided a standard for aircraft system numbering referred to as the ATA system or chapter numbers. The unique aspect of the chapter numbers is its relevance for all aircraft, so a chapter reference number for a 747 will be the same as for a BAE 125. Examples of this include Oxygen (Chapter 35), Electrical Power (Chapter 24) and Doors (Chapter 52).

ATA 100 also defined standards for writing text and instructions.

In the early 1990s a digital data appendix was added, but this needed to be standardised, and in 1994 Spec 2100 was introduced.

Spec 2100 represented a considerable amount of work carried out by the industry. Boeing was an early adopter, with the 777 being the first aircraft to use it. It identified many new requirements in relation to design work on the DTD, which led to the introduction of iSpec2100.

iSpec2100 separated digital documentation from ATA 100, more or less freezing the ATA 100 definitions. In 2000 ATA and Spec 2100 were merged into iSpec 2200.

iSpec2200 was the result of the collaboration of the global commercial aviation industry to create standards for information exchange to support engineering, maintenance, material management and flight operations.

Digital technical documentation was first introduced in 1994 using the SGML standard. As previously mentioned, Boeing first used this for the 777. Boeing also introduced SGML for its older fleet, such as the 737 and 757. Shortly after, Airbus and Bombardier started to use it.

The ATA iSpec 2200 and S1000D writing standards required documents to be written in a minimum of SGML format.

SGML became an International Organisation for Standardisation (ISO) standard in 1985. It is used to define the structure of electronic text files or documents. It is concerned primarily with structure and not with the content of the document.

It consists of text contained within a series of fields called elements which are defined by markup tags at the beginning and end of each field. These tags are contained within triangular brackets, <>. The beginning and ending tag contain the same name however the ending tag name is preceded by a forward slash, /.

SGML is designed primarily for defining the structure of electronic documents and not for direct viewing by the user. In other words it is a system of

providing structure and 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.

The Aerospace and Defence Industries Association of Europe (ASD) represents the aeronautics, space, defence and security industries in Europe. ASD was formed from the merger of the European Association of Aerospace Industries (AECMA), the European Defence Industries Group (EDIG), and EUROSPACE, the association of the European space industry.

ASD developed S1000D as an international specification for technical publications, using a Common Source Data Base (CSDB), and is used for the procurement and production of technical publications. While the title restricts its use to technical documentation, it has been proven that the principles of the specification can easily be applied to non-technical documents. The specification adopts and profiles the International Organisation for Standardisation (ISO) and World Wide Web standards.

Information generated in S1000D is in a neutral format, which means its can be used on disparate IT systems. It is this neutrality together with the modular approach to data creation and storage that makes the specification acceptable to the wider international community.

S1000D incorporates a methodology for storing data in electronic form and provides the capability to output information in electronic and, if required, paper format. The standards and DTDs for the XML IETPs are also included.

One of the most beneficial aspects of S1000D is the focus on electronic delivery through Interactive Electronic Technical Publications, otherwise known as IETPs. Through an IETP, S1000D supports multimedia content such as locater graphics, animations, simulations, hot-spots, wire highlighting, intelligent hydraulics, video, audio, digital photographs, 3D models, and virtual task training. These types of content provide just-in-time training at the exact point when a technician is preparing to perform a task and takes technical documentation to a whole new level.

Because S1000D contains a rich applicability model, IETPs can filter content the user sees depending on how the information is being viewed. For example, heavy multimedia and graphics can be fully displayed on a PC, but could be scaled back for a tablet device receiving data over a GSM network. The data can be further refined based on the equipment being serviced, skill level, environmental conditions, and other criteria.

IETPs can be integrated with other systems, such as parts inventory. In this way, a technician can simply click on a part number in the illustrated parts list to access inventory, order new parts or send live requests to the relevant purchasing departments if necessary.

S1000D even provides a specific construct for fault isolation in an IETP called a 'Process Data Module'. The process data module allows a user to interact with information in an IETP to dynamically work through fault isolation processes.

Data produced to S1000D standard is presented in a modular form (data modules). A data module is defined as 'a self contained unit of data'. Individual data modules are identified by a logical and specific numbering system, the Data Module Code (DMC), which permits the use of a database to store and manage the complete information set.

Data modules have two sections. One contains the content, which is the data required by the user, such as the

description or procedure. The other is the Identification and Status section, which contains all the metadata necessary to control the data module and its configuration. Each item of information carries all its own configuration data.

A project's complete technical publications information set is held on a CSDB. The combination of data module code, information types and DM metadata allows a selection of subsets of information to be chosen by query or table of contents designed to meet a specific user's needs. Graphic standards are supported with CGM4 (ATA profile), CALS Raster Group 4, JPEG, GIF, PNG, PDF and TIFF.

The use of a DMC ensures that information is not duplicated in the CSDB. Data that are repeated in different contexts (for example, warnings, opening and closing procedures) can be stored once as a single data module and can be used many times in different contexts. This provides considerable savings in data maintenance and enhances data configuration control. When change is required only the single DM needs to be changed, while the changed information appears throughout the output. This is an example of the basic CALS philosophy of 'create once, use many times'.

The specification contains an electronic output that is independent of any IT platform. This ensures data neutrality from the building block of the data module to the output in whatever form is required.

S1000D is currently at Issue 4.0. This is used by Boeing, while Airbus and Embraer are currently using Issue 3.0, but plan to upgrade in the future.

The complete S1000D™ specification, data dictionary and the bike data set can be downloaded from the s1000d.org website.

Manufacturers are now making documents available to airlines in S1000D for new generation aircraft, such as the A350, 787 and Bombardier's CSeries.

Thanos Kaponeridis, chief executive officer and founder at Aerosoft Inc explains that: "As we move forward to new aircraft such as the 787, A350, Bombardier CSeries and Learjet45, OEMs are using S1000D to deliver technical content, and hopefully Spec2300 for delivering flight operations content. Both S1000D and Spec2300 are XML schema-based standards, and the end user page views are created through complex data extractions and conversions. The benefit of the data's complexity, however, is that it allows direct reuse of the information (text or image) where it is applicable."

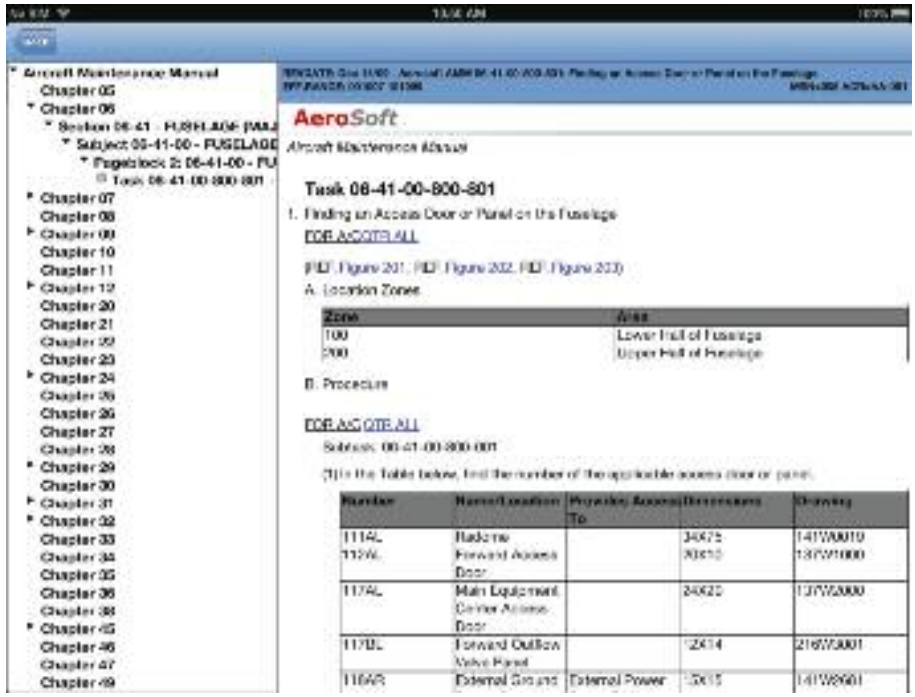
XML also allows intelligent cross-referencing, revision management, and effectivity/applicability management. It also keeps the technical data totally independent of how it will be viewed. This is important when converting for mobile devices, such as tablets and android devices, bearing in mind that some content was authored on the 787 before mobile device deliverable content was standardised.

CMS Systems

Content management system (CMS) providers and technical documentation authoring companies, such as TerraXML, Flatirons, Aerosoft and AeroDocs, use SGML and XML data kept in their respective CMSs to manage technical documentation.

A CMS's main 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.

The 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



Aerosoft's DigiDOC is a virtual CMS that is built and based on XML and Java. It provides web delivery of OEMs' technical manuals.

can also be used to search for parts, and record findings from routine tasks.

CMS systems are largely needed, since some M&E systems do not have sophisticated document management functionality. If they do, they have limited ability to handle SGML/XML content, and therefore cannot automatically manage upgrade revisions, and generate job cards electronically. The implications are that most airlines have only one choice if they wanted to use SGML/XML data. In the past the only real option was to rely on the OEMs' on-line premium services to manage revisions and updates, and generate job and task cards on their hosted systems.

A few M&E systems allow the basic management of documents and manuals, so that SGML/XML cards and OEM documentation may be stored and edited. This does not, however, cover the full functionality of a CMS.

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, an SB had been applied to an aircraft. The airline's own M&E system would be updated, but the OEM would have to be informed of the change and the reference data updated accordingly, to ensure that the right job card was applied to the aircraft in the future.

CMSs are now becoming more prevalent, with some large airlines using them as an interface with their M&E systems. Some airlines that have implemented M&E systems pay a premium for CMS add-ons provided by their M&E system vendor. Trax, for example, has produced a CMS to work in conjunction with its M&E system. Chris Reed, managing director of Trax, says that: "As with anything, there is a price point and there is familiarity. Some customers cannot afford a full (M&E) MRO solution including a CMS, so they will buy the CMS separately to reduce the cost. Others will stick with the CMS they know because they have always used it."

The main CMS providers are Enigma, Flatirons (formerly InfoTrust), Corena, IDMR, AeroDoc, TerraXML, and Aerosoft. Some M&E systems provide a CMS function. Mxi's Maintenix and Trax's Technical Library suite are examples.

Mxi's software Maintenix takes the technical documentation data in XML format from the CMS and displays it through a browser-based system, so that the user may easily access related documents that are linked via embedded links to other manuals and documents in the CMS.

The CMS extracts all the required content for the particular aircraft and renders the task card in the desired output format: HTML with electronic signature fields; or PDF with sign-off boxes.

AeroDocs's CMS product AeroDocs Manuals can manage multiple-fleet systems. Manual Manager supports Boeing, Airbus and mixed fleets. It can support effectivity by aircraft or group, and generate aircraft-specific manuals.

Aerosoft's DigiDOC programme is a virtual CMS that is built and based on XML and Java. It deploys integration and process control over the Internet through a 'logical document' concept, and provides standalone and web delivery of many OEMs' technical manuals.

Flatirons's TechSight/X Suite product is a set of applications that helps airlines create and manage flight operations manuals, maintenance manuals, company manuals, and other documentation and deliver them to users via Apple's iPad®.

Reliance on PDF

While many airlines have in place an M&E system, a wireless network, maintenance terminals or kiosks, ruggedised laptops, and the technology to sign task cards electronically, few are actually performing maintenance completely electronically. For an airline to be 100% electronic and paper-free, task cards have to be distributed to all mechanics on portable wireless computer devices.

Even with tablet computers now available for a fraction of the cost of ruggedised laptops, thereby providing most of the hardware an airline would need, it is still not possible to achieve a completely electronic and paper-free maintenance system.

Task cards can be sent to tablet computers and ruggedised laptops, but these are mostly in PDF format, because PDF is the lowest and cheapest common denominator, and most airlines still issue documentation, either task cards or work orders, electronically in PDF.

As an example, engine fleet management programme managers, receive PDF workscope estimates for approval for customers' engines that were being overhauled. These can be approved and returned by digitally signing PDF documents. This is a cumbersome and inefficient way of processing workorders. Any changes to the workscope or revisions require the whole process to be repeated.

PDF has many drawbacks from an on-line perspective. PDF document content cannot easily be searched from a HTML or browser interface, for example, limiting content 'findability'. Once a PDF technical manual or task card is downloaded and used off-line there is no way to ensure updates are delivered, without re-delivering the updated content. A licence for Adobe Acrobat is needed for each end user that performs any editorial or markup actions.

Nevertheless, PDF does have its benefits, including consistent layout and off-line accessibility. PDF displays embedded images well in a large variety of formats, and is also easy to annotate. It

can be digitally signed and returned. It is also easy to print, with modern printers that have memory card and Universal Serial Bus (USB) memory stick readers, only requiring direction to the file location to print the PDF document. It can be shared by email, although size restrictions may apply to the recipient's e-mail server.

HTML delivery

One of the most efficient ways to deliver technical documentation is to generate or deliver them in HTML format. This requires the data to be processed or rendered where the data is taken from a SGML or XML source file provided by the OEM or from a CMS. Technical documents in HTML can be signed off electronically and an entire record of the process remains in electronic format.

Converting data into XML

HTML has extensive benefits in that it can be easily customised to the recipient's device, including mobile ones. The content can be interactive, so task cards can contain embedded links to the AMM or IPC data. Mechanics can also request parts.

HTML is easy to update, which ensures that the document being delivered is the latest version. HTML is easy to search within, since the browser's search tools interact with the HTML delivered XML data. A simple search can be instigated just by pressing CTRL+F or APPLE+F. This opens a search window which enables easy scanning. HTML data can be shared by link rather than by hard file transfer, which removes the size restrictions associated with PDF files. Supplementary material can easily be included in link format, rather than being sent as additional files for reference purposes.

Summary

Accuracy is the prime requirement when converting data in the aerospace industry. This is a challenge, given that the process typically requires zero data loss, output to multiple formats, and well-structured outputs viewable on a wide range of formats.

On top of this, a successful data conversion must minimise manual review. If not, the process can require an army of subject matter experts and could incur lengthy delays to technical updates.

Boeing has chosen XML as the intermediary format to establish successful data conversion processes, because converting data into XML provides a foundation for accurate formatting and reporting. Further, XML-based data, tools, and processes provide an excellent foundation for automated quality audit and data production to multiple output formats.

Even with this ability to deliver technical documents electronically to tablet computers and mobile devices, many small airlines still generate task cards and create task documentation in PDF format, while others are still using paper task card systems.

This is not a simple change-over. In some cases entire business processes require new management thinking to change them. The airline's M&E system has to handle complex processes, such as converting OEM-provided SGML or XML CGM data into a dynamically-deliverable XML format, that can be viewed on multiple output devices.

A page view may be generated combining the MPD and AMM with links to the IPC, all in a HTML format. It is only through careful consideration and a detailed and thorough process, with suitably qualified technical individuals that understand the airline or operator's business and technical needs, that a CMS that is often integrated with a M&E system, should be chosen. AC