There are five main scenarios where there is a need to transfer data between M&E/CMS systems operated by airlines and MROs. The technical issues and the data transfer process are examined and considered.

The complexities of data transfer between M&E & CMS systems

Data interchange between maintenance and engineering (M&E) systems, or M&E systems combined with a content management system (CMS), has always been a complex issue, and one that causes difficulties.

The interchange of aircraft configuration and maintenance data, and original equipment manufacturer (OEM) and airline-authored digital documents and data, occurs in five main scenarios.

The first of these occurs when an airline or maintenance, repair and overhaul (MRO) provider changes to a new M&E system or combined M&E/CMS system. This may represent the largest transfer of data.

The second is when an aircraft moves from one airline to another with a different M&E system. Similarly, the third main scenario is when a leased aircraft is returned to a lessor at lease-end. In both cases the aircraft's maintenance status has to be accurately assessed, and all the data transferred to a new operator's system.

The fourth scenario occurs when aircraft are sub-leased temporarily by an airline to another operator for a period of months, and then returned to the first operator in a regular manner. Data transfer is complicated when the two airlines have different M&E systems, and differences in their data standards. The ideal solution in this scenario is for the two carriers to use the same system.

The fifth scenario is when an airline sub-contracts maintenance to a third-party supplier, and wishes to supply digital data rather than prepared printed job cards. The data then have to be transferred back to the airline when the maintenance is complete in digital form.

In all five scenarios a large volume of data has to be transferred. Each scenario has its own variations and challenges, but there are some similarities.

Changing M&E/CMS systems

The main requirement for data transfer is an airline or MRO acquiring a new M&E/CMS system. "The main reason for changing the M&E/CMS system is the user requiring an improvement in system functionality and technology," says Paul Saunders, solutions manager at Flatirons Solutions. "Some systems used by airlines are mainframe and early-generation M&E systems with limited or outdated functionality. An example is where not enough detail on aircraft configuration and rotable components is tracked in an old M&E system. A current system may only track part number (P/N), serial number (S/N), component location and position, and fitting date. Other parameters that may need to be monitored are flight hours (FH) and flight cycles (FC) accumulated since the component was installed on the aircraft.

"Another example of improved functionality is that old systems often only track life-limited parts (LLPs), while younger-generation systems also track on-condition and condition-monitored parts," adds Saunders. "It is common for airlines to adopt a new-generation M&E system when they take delivery of the newest types, like the 787 and A350, which use the S1000D data standard. It is also common for airlines to change the M&E system when acquiring other modern types such as the A320, 737NG and 777, which use the iSpec 2200 data standards, so that they can benefit from better system functionality."

Another reason for system upgrade is that the main M&E system may have to be integrated with other systems, or point solutions, and to exchange a lot of detailed information with them. Point solutions specialise in provisioning and maintenance planning strategies, by analysing and comparing OEM recommendations with actual fleet experience and history. These must be integrated with modern M&E systems.

Swiss Aviation Software's (Swiss-AS) AMOS system, for example, interfaces with any external system via the AMOS Adaptive Integration Manager (AIM). This contains numerous schemas for extensible mark-up language (XML). These allow data to be imported or exported in a structured way.

An example of interfacing with a point solution is a maintenance check planning and production module transferring information to and from a human resources (HR) module. "This is because each mechanic's hours, logged during a check, may also need to be recorded in the HR module, and there are various categories of data in the HR module about each employee that are required when planning and executing a maintenance visit," explains Saunders. "These include a mechanic's licence type, validity, and their available hours."

Modern M&E systems also have sophisticated algorithms that improve their functionality level, and accurately plan a maintenance visit in detail.

Data transfer problems

The problem with transferring data between M&E or M&E/CMS systems is that there are no internationally or industry-wide adopted interchange standards for data. Standardisation would allow data to be transferred with 100% integrity.

All M&E systems operate around databases that store data on inventory, aircraft configuration, components and maintenance. Examples are aircraft configuration, structure and component location as defined by air transport association (ATA) chapters and configuration number, the AMTOSS code system, and ATA 200 guidelines for

part number (P/N) definition. While these have provided definitions for several decades, they are not systems that all airlines and MROs are obliged to use, so they are only guidelines. As such they are not accepted universally, and many airlines and MROs have developed their own numbering systems.

This means that while ATA 200 uses 20 digits and letters to define P/Ns, many airlines have adopted their own P/N definition systems that can have more or fewer than 20 characters. "At one time, ATA used 235 characters, but Airbus changed to 30 characters for a P/N definition," says Chris Reed, managing director of Trax. "An airline with its own P/N system is Virgin Atlantic, which used 15 characters, and had to build a cross-reference table to deal with P/Ns."

There are similar variations in serial number (S/N) definitions, but Swiss-AS's AMOS uses data formats that adhere to industry specifications as much as possible. For example, AMOS verifies that P/Ns adhere to ATA100/200 standards. AMOS also uses user-defined basic data tables, which forces users to achieve data consistency.

Different systems exist because they were not all originally built for ATA standards, or were developed before Spec 2000 standards were established. One reason an airline has its own numbering system is that it has its own approved parts list (APL). This is a list of the different P/Ns it has approved for each part or component fitted on the aircraft. In many situations, non-aircraft data other than aircraft parts were tracked by M&E systems which led to this divergence on data type and sizes.

This is the cause of the basic problem with data transfer between M&E systems: no current system was built from scratch using the published ATA standards. Many M&E systems are simply based on original inventory management or financial management systems, and they have adapted various standards. Capabilities such as enforcing configuration, planning and logistics, and financial analysis were added on the way.

"Not only have M&E systems evolved differently, but they also use different database structures," says Thanos Kaponeridis, chief executive officer at Aerosoft. "There are differences in each system's database tables, and how the data are stored and used by the application, and also how different links are created between the database tables that create referential integrity. In some cases, this results in the same data living in two places and requiring synchronised changes."

James Elliott, production marketing manager at Mxi Technologies points out that new systems operate on modern databases, such as Maintenix which operates on Oracle 11g. This allows modern digital data to be used, so more content can be stored.

An advantage of modern databases is that they allow the user to define the number of characters used for each parameter. The fact that each M&E system has its own standards for P/Ns, S/Ns and other definitions, and that each system user may have developed its own definitions, is less of a problem with a system that uses a modern database. Each system uses a different number of characters to define a value or parameter. Reed makes the point that it is easier to manage differences among airlines on modern databases, and says that M&E systems need to modernise to handle the differences in user definitions.

The differences in user definitions in older systems creates just one of the problems when transferring data. One of many examples is the two, four, six or more digits for ATA coding, all the way to full AMTOSS code numbering for maintenance tasks.

All the data for each parameter have to be converted to a new standard when changing system. A small number of characters converts easily to a larger field. Converting a larger number of characters to a smaller field is complex, especially if it is a recurring issue.

M&E systems also track different parameters and data sets to calculate

values. This is another difficulty when transferring data between M&E systems.

With the 787, for example, its documents are supplied in digital form, and many of its components are supplied as software. New software is sent to operators to update the components, and the M&E system has to be able to handle these revisions. Reed points out that old M&E systems lack this functionality.

The overall issue is that the data used by M&E/CMS systems are not standardised, and there is no comprehensive, practical and fully adopted or adapted interchange standard that system vendors have to adhere to.

Transferring data between M&E/CMS systems is also complicated by the structures of the databases within the M&E systems, and the different formats in which the data are kept.

There have been several industry attempts to create a single data standard for all M&E/CMS systems, but none have gained any real momentum.

Elliott says that all M&E vendors are likely to agree to a standard, but airlines are likely to say that some data, such as the purchase price of parts or mechanic labour rates, are private and cannot be transferred. Elliott says that an international standard would enable airlines to prepare, and to save money on data formatting costs.

John Stone, vice president of product management at Ultramain, advocates adherence to open standards. "It should be stated that many standards that exist today require updating to accommodate the advances in IT systems."

Transfer process

"Transferring information does not just involve taking all the data from the airline's original system, putting it into the new system, and then continuing with the aircraft's operation," says Kaponeridis. "The design differences between M&E systems make it necessary to have a system in which to convert and process the data. This conversion system is called a staging database. Data are exported from the current M&E system into the staging database, where they are processed and converted. They are then imported into the new M&E system by proprietary software, since the internal data structures of each M&E system are always proprietary and different."

The process is started by M&E/CMS system vendors preparing the staging database, which can be Excel files, for the airline data to be imported from the current M&E system. Each vendor has its own system to assist airlines and MROs when implementing a new system. "Mxi's Maintenix system has a standard data format, and we explain to customers clearly how it works," says Elliott. "We have standard templates for data conversion and processing when transferring from an older M&E system. These are either Excel or database files. The data are loaded into Maintenix from these files."

Reed at Trax says the process starts by determining what data the system user has, and its format. "The data could be in Excel files from an old mainframe system," says Reed. "The next step is to decide what data to use, and how many years of data need to be transferred. The user does not necessarily need to go back to birth for all the aircraft. All compliance data, however, relating to items such as ADs and SBs performed on the aircraft do have to be kept. A back-up of all data is also kept.

"The converted and processed data are then mapped to the new system," continues Reed. "That is, what was a field name and P/N in the old system, and what it is called in the new system. The conversion programme can then be written, which can be standardised or custom-built. Data are taken from the old system into the staging databases. The data are converted, before finally being imported into the new system."

Swiss-AS starts the data migration by scoping the necessary data, identifying

the source, and mapping and then extracting the data with an extract, transform and load system. The data are then converted into an AMOS-defined text file format. The files are reviewed before being uploaded directly into the database via AMOS and its set of import modules. AMOS has logic to import these simplified text files into the required database tables. Each imported data file is verified for consistency.

Once the data are in place, they are validated, because they may contain invalid values or breaches in referential integrity. The conversion to the formats and standards used by the new M&E system can then commence.

Problems can occur with data conversion between M&E systems, depending on type of conversion being carried out in the first place.

The first type of conversion is when switching from one M&E system to a new M&E system or M&E/CMS system.

"The first type of data conversion in this case is the different formats used for P/Ns," says Kaponeridis. "The staging databases or conversion Excel files will have algorithms to convert the old style P/N into the new P/N.

"Another conversion process is that M&E systems use different numbers of data sets to determine particular values," continues Kaponeridis. "A current M&E/CMS may use data that are in two columns in the conversion Excel files, while the new system uses three columns. An algorithm will therefore be required to create this third column of data, or condense three columns of data into two columns for the reverse conversion."

A main difficulty with the data transfer and conversion process to a new M&E system is that it can take several months for a single aircraft type and all the aircraft in the fleet. "It takes several weeks or even months to set up the staging databases and conversion files for an individual aircraft type," says Saunders. "In addition, different variants need their own staging databases. For example, the 737-700 needs different staging databases than a 737-800."

Some airlines do not transfer historical data because the process is too complex and expensive, so the legacy or old system is maintained on standby for several years to access historical data. This is regulated in some jurisdictions.

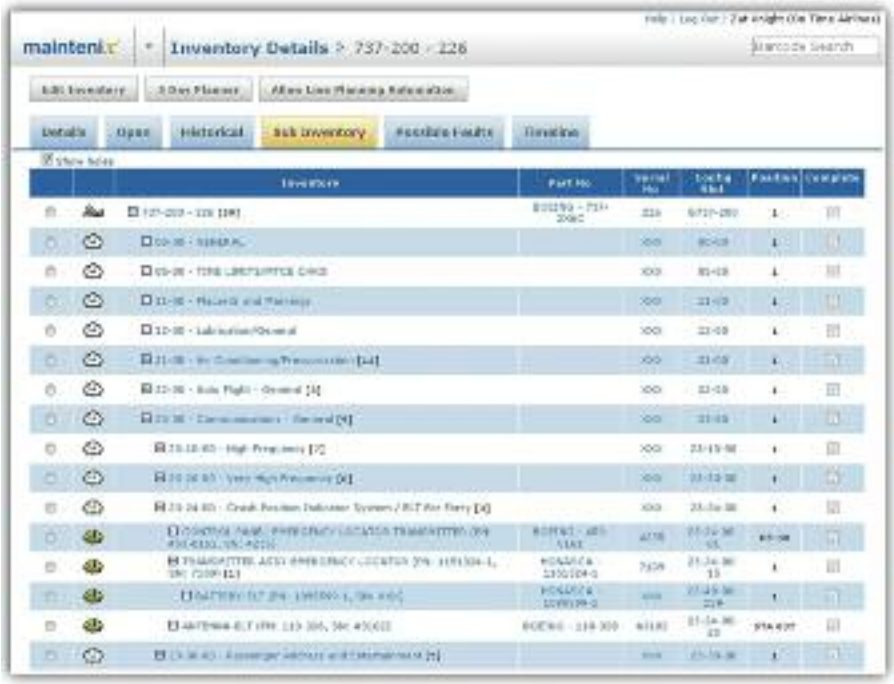
A more complex piece of information is which mechanic (name and licence) performed which task card five years ago in a C check. This is left behind in the old system, although this information may be key, in some scenarios, to predicting the failure of that component used on a different aircraft or operator.

After creating all the staging databases for an aircraft type or variant, data are transferred to the staging databases and converted or processed for individual aircraft one at a time. "It takes the equivalent of one man-week of an engineer's labour to process the data for an aircraft in the staging databases," says Saunders. "The problem is that, as it operates, an aircraft's configuration and maintenance-related data constantly change, so the best time to convert to a new M&E system, for an existing fleet, is each time an aircraft is in the hangar for a maintenance visit. This makes it relatively easy, although more data are produced as maintenance is performed.

Many unanticipated problems can be encountered during the conversion process, especially for the first few aircraft. Staging databases may have to be modified several times.

Reed says that data must undergo a validation test and audit after migration. "There are inevitably problems that have to be fixed and the system is then re-run three or four times," says Reed. "Each time the percentage of errors is reduced, and eventually the user can go live with the new system."

"An airline can manage an M&E/CMS system transfer process in several ways," says Saunders. "The first is to simply keep the current M&E system operating for the legacy fleets



The inventory screen in Maintenix highlights the configuration of a specific tail number, and represents the as-maintained configuration of the aircraft. This would be key information exchanged between different parties.

until the airline phases them out, and use a new M&E system for new fleets as they are added. The airline will run the old and new M&E/CMS in parallel, until all the legacy aircraft are phased out and the old M&E/CMS is no longer needed. This avoids the lengthy data conversion and transfer process, so it is relatively easy."

Information is required on a fleetwide basis, however, so using two systems in parallel for two different fleets can be difficult or even impossible.

"The second method is to transfer the data for each aircraft to a new M&E system over an extended period," continues Saunders. "The two M&E systems will operate in parallel while the conversion is in process. It is easiest to do the conversion while the aircraft is undergoing a lengthy maintenance visit."

In many cases, changes to a new M&E system are made on a fleetwide basis, in a single transfer process. This requires a long lead time, of up to one year, to prepare the staging databases and conversion programmes. It can then take a few years to process and change all the data for an airline's fleet types.

Reed estimates that the process can take 4-6 months for a small or medium airline and 12-18 months for a large one.

"Since each M&E system is structured differently, a unique set of staging databases is required when transferring from M&E system A to system B, plus all the other types of M&E systems. Yet another set of staging databases is needed for conversion from B to A, and all the other types of M&E systems," says Kaponeridis. "If there are N available M&E systems on the market, then the number of staging databases that have to be created is N squared minus 1. That is, if N equals 20 systems then 399 sets of staging databases are needed to transfer between any of the two systems and all possible conversions.

"What is required is a universal staging database conversion system that could handle all possible conversions," continues Kaponeridis. "The maximum number of data conversions would be N minus one, so 39 sets of conversion files would be needed if there were 20 systems on the market. Developing a universal data conversion process would require all major M&E vendors and MRO suppliers to work together to write a common set or adapt an existing and evolving set (or adopt/adapt an existing set of standards) into a set of conversion files."

A similar process of data conversion and transfer is required when aircraft move to a new operator with a different M&E system via a lessor.

Directly transferring an aircraft to a new airline will still require the creation of staging databases. Transferring via a lessor will be more complex, since lessors always want to assess the aircraft's maintenance status. Some bridging maintenance or interior refurbishment may have to be done, often by an independent MRO, before the aircraft is transferred to the new operator. Two sets of data conversion may, therefore, be required for each of these stages.

Dual parties

There are two scenarios in which the aircraft and its data are regularly transferred back and forth between the airline and another party (which can be an airline or an independent MRO).

Problems arise when sub-leasing and transferring an aircraft back and forth for several months between two operators with different M&E systems.

"The first is that data are enriched after being imported and transferred into a new M&E system," continues Kaponeridis. "For example, if there is a change in the maintenance programme from the manufacturer's maintenance planning document (MPD) to the operator's own approved maintenance programme (AMP), task groups and intervals will have to be changed each time the aircraft is transferred."

Each airline also has its own customer-oriented changes (COCs) to tasks and task groups. These are customised additions to maintenance tasks that also have to be changed each time the aircraft is transferred. Non-routine tasks may be tracked differently.

So, work orders generated for airline A's M&E system have no relevance in airline B's M&E system. New workpackages have to be created for the new operator's operation, business processes, databases, and workforce.

Another problem is that the airline or maintenance facility may change its standard operating procedures (SOPs) for maintenance production. This also affects how work orders are bundled.

"The aircraft will operate with the new airline and be maintained relative to its AMP. Any relevant airworthiness directives (ADs) and service bulletins (SBs) will be performed," continues Kaponeridis. "As maintenance is carried out, findings are recorded by mechanics, and pilots' tech log entries are added. The aircraft's component configuration, and therefore component-related data, are constantly changing. The relevant digital versions of 8130 documents or Form 1s also have to be recorded."

These changes and data enrichment cause a problem when the aircraft is transferred back to the first operator after six or more months. Not only do the data have to be converted back to the first M&E system's configuration, but the COCs, AMP customisations, and work order packages all have to be converted back to the previous AMP.

Another issue is that new referential integrity rules get established with a new M&E system. Some M&E systems keep track of certain parameters or data in multiple places. Referential integrity ensures that the data are updated and modified to the correct level in all database locations. Legacy systems do this with programming code, while new systems do this with proper data design and database engine features.

A problem can arise in legacy systems

The AD status report in Maintenix shows the current AD status of a single aircraft. This is a critical part of an aircraft's maintenance record that has to be transferred or exchanged with another M&E system. This report can run for several pages.

when there is a change, such as the S/N installed in a particular location on the aircraft. This change may be recorded in one location on the database, but not in others. Contemporary M&E systems have intelligent ways of associating data sets. Referential integrity is a database structure concept that means that data are kept in one place, and associations created between data sets are made in one way. Associations between data sets can be lost, however, whenever a set of data is transferred between M&E systems, so referential integrity has to be re-established each time.

Sub-contracting maintenance is another common problem for virtually every aircraft. A third-party supplier will often use a different M&E system than the airline customer. Even in the very few cases where both parties use the same M&E system, the MRO will have different standards, such as P/N definitions, to the airline, so there will always be difficulties transferring data between airlines and MROs.

Some vendors have devised ways to mitigate some of the difficulties. "Mxi has created standard outputs of data that airlines use to request a proposal to a MRO," says Elliott. "This involves sending a package of maintenance data. If the MRO has a long-term relationship with the airline it will have adapted its M&E system to understand key data, such as task card numbers that Maintenix uses."

Long-term relationships between airlines and MROs mean they can develop systems so each can accept data from the other's M&E system. It can take 100 man-hours (MH) to convert data back from the MRO's system to the airline's system, so Mxi has created a standard data extract that summarises all maintenance performed by the MRO.

"It is easy for an airline to use the old method of preparing paper task and job cards, and sending them with the aircraft to the MRO," says Kaponeridis. "It is difficult to completely interchange all data, including security and traceability information, captured during maintenance execution between the two parties. In some cases, 'intelligent' or conditional task cards must be executed and results captured in the process."

Intelligent task cards require the data used to generate them to be in a digital form, rather than being printed on paper. Digital data can be viewed on computer screens. The third factor in intelligent task cards is that a mechanic sometimes has to respond to a request on the task card to read or measure a value. The data the mechanic then enters may prompt a further task, or an instruction to recalibrate or remove an item, such as a component. This interaction between the mechanic and the card requires it to have 'intelligence'.

Intelligent cards, and associated data, must then be transferred to the original system. If the original system does not have intelligent job cards, one intelligent card may have to be split into two or three static cards that contain all the relevant information.

"Another issue is that the airline and MROs want different things," continues Kaponeridis. "The MRO wants to track the progress of the check, the utilisation of its hangars, and the inputs of MH, materials and parts. Airlines, however, want completed and signed task and job cards, airworthiness certificates for exchanged components (Form 1s and 8130s), a list of non-routine cards that had to be performed, the component and configuration changes, and compliance with implementing ADs, SBs and EOs, and proof that they are abiding by the intent of the OEMs' MPDs."

Digital data

Manually transferring data and keying it into an M&E system is laborious and no longer viable. The only solution is to have these data in a digital form, with the advantage that intelligent task cards can be created and used. The internet has made it possible to distribute documents electronically and digitally.

For several decades documents were written to ATA 100 standards, and were printed in paper format. The standards were upgraded to ATA Spec 2100 in 1994. ATA 100 and 2100 were consolidated to iSpec 2200 in 2000.

In parallel with the new iSpec 2200 document standards, new technology for presenting documents was introduced. The first was standard generalised mark-up language (SGML), which provides intelligence to a document. Part of iSpec 2200 is having an intelligent format in writing manuals and documents, and iSpec 2200 adopted SGML for this. The intelligence of SGML provides organisational structure, tagging for component P/Ns, and other qualities.

Document type definitions (DTDs) determine the structure in SGML of maintenance documents. These are items such as the AMM, FIM, troubleshooting manual (TSM), structural repair manual (SRM), and the illustrated parts catalogue (IPC). SGML documents and manuals were provided for Boeing types from the 737 Classics to the 747-8, and for all Airbus types from the A300-600 to the A380. The standard used in these documents is iSpec 2200.

SGML was followed by extensible mark-up language (XML), which does not have SGML's shortcomings. XML is a more advanced system of writing intelligent documents.

The latest documentation standard for the 787, A350 and CSeries is S1000D. XML provides intelligence to data supplied in S1000D standard. Manuals written in iSpec 2200 standard can be converted to S1000D, and then from SGML into XML.

"The best way of transferring digital data is in XML structure, because XML allows a schema and transactions to be

The most common scenario where data is transferred back and forth between parties is the regular sub-contracting of maintenance to third party maintenance providers. Some of the problems related to such data transfers start with the fact that a MRO will almost always have different standards and definitions in its M&E system to the airline.

defined," claims Kaponeridis.

This allows data, and their structure, to be transferred to another party, and validated. This means that when the MRO receives the data, no manipulation is required, and the conversion programme that has been developed works every time. For example, when a digital task or job card is completed and signed off, the digital signature has to be captured and another recognised standard for this is Spec 42, which ensures authentication and security.

"Most M&E systems work on SQL databases, and XML is used for the technical content of manuals," says Kaponeridis. "For example, the content on the job cards, the instructions on how to perform the work, and the format for presenting it on paper or a screen, are coded in XML, as are the signature or authorisation provision.

"The header information, although it has XML structure elements, is populated from the M&E System's SQL database. This comes with visit-specific information such as tail, date, base, P/N and S/N on/off, and level of check, and logged hours," continues Kaponeridis.

A CMS is required to work with the M&E System to manage this complexity.

Mxi has developed a system for transferring XML data between airline and MRO systems, where the MRO's system does not use XML. Mxi extracts the data in XML, puts it into XML Excel files, and then sends it to the MRO.

Like Mxi, Swiss-AS's AMOS contains a set of XML interfaces developed to handle the regular transfer of data between airlines and MROs. Solutions to exchange data for complete maintenance workpackages and content are in use by airlines. Swiss-AS has jointly implemented integrated system interfaces between AMOS and SAP, that is used by SR Technics, allowing maintenance data carried out to be returned to AMOS.

CMS function

A paper library was appropriate for paper manuals, which also had temporary revisions (TRs) on yellow paper, and so on. This was known as the ATA 100 generation.

In the paper world, the librarian would receive a paper package from the OEM and then file it in the appropriate manual, chapter, section, and subject pageblock. This would be aided by 'front matter' in the manuals. This described a list of effective pages and the reason for the changes. Also, revisions were marked on the side of each page, indicating where the change had been applied. For a full revision they would remove the old or superseded pages, or insert a TR alongside the previous revision.

Mechanics or planners needing information from the AMM or FIM would photocopy pages, and staple them to other printed documents or use them as source material to retype portions into other documents.

SGML- and XML-based digital data are treated very differently. A digital exchange of data requires a 'digital data library', with many more features than the shelves of a typical library.

When the files in SGML and XML are received from the OEM, they cannot be visually inspected, so computer programmes need to validate that the file data is structurally correct, and can be used to create readable views, either on paper or computer screens. Also, when reusing the content or structure of primary documents, the user should create links and references between the data so that the original information stays in one place.

CMSs with various capabilities have emerged to manage the above, and other more detailed business processes. These include items such as EO creation, non-routine authoring, COC authoring with change authority captured, and compliance to regulations. These systems were developed to manage the challenge of 'reusable data' at the OEMs, and then migrated to airlines and MROs.

It became imperative to have a CMS with the advent of SGML and XML data. The original data for a new aircraft come from the OEM.

Supplementary data, however, can come in a component maintenance manual (CMM). Also, authorities can issue ADs, which drive the creation of SBs, which in turn are generated when OEMs apply modifications to the product line to improve a design, or recommend a process of maintenance.

The aircraft and engine types, whose data and documentation are written in iSpec2200 standards, have their documentation supplied in SGML format. The 777 was the first type to use iSpec 2200 documentation standards, and several other types including the 737NG, the A380 and 747-8 have their documentation written in iSpec2200 standards and provided in SGML format. Most older jet types have documentation provided in PDF, but comply to ATA 100 and AMTOSS.

Documentation for the most recent aircraft types, the 787, A350, and the CSeries, is written in S1000D standard. S1000D, however, is still evolving. Release 3.0 for the 787 is different from release 4.2 for the A350. The underlying data description language used for this information set is XML.

"The SGML or XML data are transferred into the CMS, and kept as little pieces of XML, rather than whole documents," explains Kaponeridis.

Raw XML data from the OEM is manipulated when the airline makes COCs, but there are also associated meta data when maintenance is performed, including information such as when and where a task was performed and by whom, or tracking why a COC was made. The XML data are updated as the

The use of a CMS and data in XML format makes it easier to transfer data between an airline's and a MRO's M&E systems.

aircraft is operated and maintained.

"The original set of OEM (XML or SGML) data is unchanged in a CMS as the first set of data," says Kaponeridis. "Then there is a second set of data, an airline version, where the COCs are managed. The airline can also generate task cards, EOs and attach ADs and SBs in this version. The operator can track which engineer authored COCs. These processes all happen in the CMS. The third set of data is the XML meta data."

Meta data capture information outside the original or revised content, such as the 'who, what, when, why, and where' changes were made, or details of SBs carried out. This allows the relevance of information to be correctly assessed before being presented to the reader about a given aircraft, for example, capturing the change authority driving an interval change to an airline AMP.

Viewed material that appears as manuals to the system user are formatted (by a CMS) from the data modules, which is in the S1000D schema. It is enhanced with attributes necessary to make them visible on a computer screen, and therefore usable by mechanics who expect to see a page from a manual.

Viewing XML data requires a formatting transformation, and in some cases this is an interactive electronic technical publication (IETP). The IETP provides an intelligible view of the XML data so that it looks like a manual when viewed on screen. It has intelligent links, however, and the ability to attach 'sticky notes' or comments. It also ideally resolves effectivity per fleet configuration, and accomplishment of SBs. The IETP has links to other manuals, and different IETPs each have different programmes to make them viewable on any type of device, including PDF for paper, computer terminals, tablets, or mobile smartphones.

The IETPs often combine the original OEM data with the COC versions. The formatting and validation of links, and what to show and what to hide in IETPs are written by the CMS vendor and are proprietary. These formatting transformations, again in XML, are proprietary to each CMS provider. The formatting data are therefore not included when an S1000D collection is sent from one CMS to another.

Changing CMS

There are several problems when moving data from one CMS to another.

"The problem when moving data to a new CMS is that the meta data and viewing programmes are proprietary, and cannot be transferred, " says Kaponeridis. "This means that when the CMS provider is changed the airline or system user only gets the raw data as supplied by the OEM plus the COC if they were authored to a standard schema or DTD. This means that the new CMS provider has to extract the raw OEM data, and try to extract the COCs and re-implement them with their tools for IETP or screen preview. If it cannot extract the meta data it has to re-write it again and create the viewing programmes."

Another issue is that all the original links between the M&E system and the CMS were built by the user or operator, often with the co-operation of the M&E/CMS vendors. The new set of M&E/CMS has to feature the same standard capabilities to have the same interfaces and links.

While a large number of staging databases have to be generated to handle every possible combination of transfers between M&E systems, there are an even larger number of permutations of combined M&E/CMS systems. The number of systems (N) squared minus one, therefore gets very large.

Transfer between M&E/CMS

There are several issues to consider when transferring data between two sets of M&E/CMS systems, for example, from an airline to an independent MRO. "First, the airline and MRO have to agree on the XML task card and workpackage schema," explains Kaponeridis. "At the source airline what we call a task card is in fact populated jointly by the M&E and the CMS. That is, a data model for the XML data. The XML data is converted into the agreed schema before sending it to the MRO. The data are then sent to the MRO, and converted from the agreed schema to its own format.

"After maintenance is carried out, the XML data are sent back to the airline," continues Kaponeridis. "The most significant items that are transferred are the signed-off task cards and the 8130s/Form 1s. Additional non-routine items may also be captured, however, at the MRO, for which in-bound task cards may not have been pre-supplied. The complexity is that the data is enriched by the MRO in this case, and this makes it more difficult for the airline to receive it back and distribute it to their M&E and CMS respectively. A universal interchange standard would be ideal."

Stone comments that the complexity of transferring and converting data between airlines and MROs depends partially on the decision to include or exclude historical data. Generally, data is migrated via standard import tools. Depending on the quality of data, custom data validation algorithms are created to ensure proper data transfer. "It would be possible to create a universal data standard for moving data between different M&E/CMS combinations," says Stone. "Once vendors are on board, operators and MROs must buy into the concept. It will not be a speedy transition, however." AC