

Airline engineering departments and maintenance providers have to manage a constant flood of ADs & SBs that are issued by airworthiness authorities. Geoff Hughes examines how some of the systems available deal with and keep track of these modifications and the aircraft they affect.

MRO IT systems for managing ADs & SBs

Commercial aviation is the most tightly regulated and controlled industry in the world, after nuclear energy. Aircraft safety involves a wealth of checks and balances that ensure the maintenance and modification status of the aircraft, and all the work carried out on it, conform to a rigid set of rules. Controlling the engineering and modification status of an aircraft means keeping track of a large amount of paperwork and electronic publications from manufacturers and civil aviation regulators like the Federal Aviation Administration (FAA) and Joint Airworthiness Authority (JAA). Staying in control is a challenge for any engineering manager or director.

This article examines the capabilities of various IT systems to assist engineering departments in managing the modification status of aircraft. This will include comments from airlines about the benefits of implementing some of these new technologies.

Engineering change process

The regulatory process controlling civil aviation is complex and varies from region to region. In the US, there is a long-standing process controlled by the FAA that issues instructions for changes to aircraft, and monitors compliance with these instructions.

Adam Frost, engineering manager at TNT Airways based in Stansted, UK, explains the differences between the FAA's approach to Airworthiness Directives (ADs) and Service Bulletins (SBs), and the Europeans'. "The FAA has had a long time to refine its approach to the whole issue of engineering change management, and it is generally simpler and more straightforward than the JAA's approach. The FAA issues both the notification for a change, as well as the instructions on how to implement it.

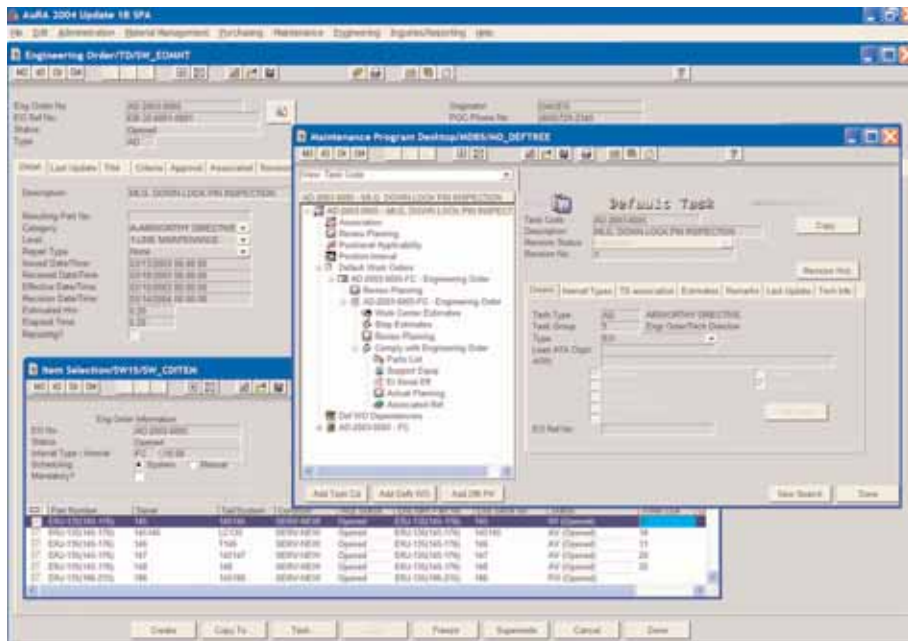
"Europe is different," continues Frost. "First, we face the issue of fragmentation. Each country has its own aviation regulation framework, and legal system. Most countries issue just the notification of the engineering change, and rely on the Original Equipment Manufacturer (OEM) to issue the accompanying instructions on how to implement the change. While there is a move towards harmonisation, especially now that EASA has taken over from the JAA, there is still a way to go, and any harmonisation will be limited by differing legal systems in each country. So for example, for the BAe146 freighters that we operate, we will receive an AD from the UK Civil Aviation Authority (CAA). But our French-registered aircraft will also have an AD issued by the French Authority, the DGAC. One of the most beneficial changes would be a simple harmonisation of numbering systems for issuing ADs and SBs across authorities."

Frost continues: "A TNT the technical library will receive all external notifications and documents. These will be logged upon receipt and we will decide if action needs to be taken and by when. It will then be loaded into our maintenance repair and overhaul (MRO) system for tracking. We will also build the internal technical order that will instruct the organisation as to what maintenance or engineering action is needed. Within AuRA, our new integrated MRO software from MIRO Technologies, we can schedule the implementation of the AD or SB. We can also control and track the maintenance actions, build the technical order and attach a job card, so everything is centralised in one system. Our level of control and visibility is significantly increased. We can also attach all the relative documents electronically, including the original AD or SB and all communications regarding the change.

We use AuRA's e-mail capability, integrated with our MS Exchange e-mail system, to drive the electronic authorisation and sign-off process as a real-time workflow. At the back end of the process we have a Certificate of Maintenance Review (CMR) that lists all the engineering actions that have taken place on the aircraft, including a full AD status. Our on-line AuRA system makes the CMR process much easier."

MRO systems must not only deal with the complex documents received from external sources, but also with the sometimes complex maintenance requirements that can result. Large modifications can be divided up to spread the load. Alternatively, there may be multiple methods of complying with the change that need to be managed simultaneously. Add to this the need to control internally generated engineering changes, and the associated need to control authorisation and communication both inside and outside the airline, and it is easy to see why the software needs to be equally complex and the functionality broad. Engineering change means that airlines need to reach multi-faceted financial and commercial decisions. For example, if a change is not mandatory, then there is likely to be a detailed Return on Investment (RoI) case to be developed and argued. Add to that the need to balance engineering changes with return conditions and dates for leased aircraft, and this already difficult task for engineering becomes more significant. The opportunities to improve the process can yield large savings in time and manpower, however, and well planned engineering change can save millions. Both RAMCO and TRAX, analysed here in more detail, have functionality to assist in capturing the RoI data.

Carsten Fleer, vice president business unit MRO at Lufthansa Systems says: "The airline and aviation industry can



benefit from Lufthansa Systems' expertise as a systems integrator. We have proven experience of the highly complex maintenance and repair procedures employed within the industry. MRO demands high standards of quality, safety and accountability. Routine maintenance, repair of rotatable parts in the workshop, or the scheduled overhaul as part of a D-check all make great demands on the available technology. We not only know the MRO processes in detail, but also know which IT applications provide the best value in different situations. Thanks to our many years of experience as a certified Customer Competence Centre for SAP R/3, Lufthansa Systems is one of the leading SAP suppliers in the field of airline maintenance. We have already proven our capabilities on numerous occasions, particularly over the past three years, in the successful consulting and planning of major international SAP R/3 Aerospace & Defence (A&D) projects. The solution is an innovative system that allows customers to continually expand IT processes in MRO. It is capable of mapping all important business processes in an integrated IT system, from maintenance and repair to pilot deployment planning, right through to administrative processes."

Although SAP has traditionally been the preserve of only the large and deep-pocketed airlines, Lufthansa Cityline is the exception to that rule. The regional arm of Lufthansa had to upgrade its in-house maintenance and engineering systems and made a choice to rely on Lufthansa Systems to provide the solution. Matthias Krause, general manager engineering at Lufthansa Cityline, describes the journey that his airline embarked upon in 2002. "In earlier years, Lufthansa CityLine's IT systems for maintenance and engineering were like a collection of small atolls in the

middle of the vast South Pacific ocean, connected together with very thin, flimsy, wooden gangways. Now with our new system we are all on one single island, with all the separate hills now accessible by dry land. You can move through the island quickly without having to change boats or get your feet wet, and dropping important information into the sea, to be lost between the islands.

"For example, it used to take two to three days to get the paperwork back from the various maintenance locations on the completion of a modification," continues Krause. "Then data entry into a database could add a further delay. Overall, it could take a week from physical implementation to electronic recording and visibility to the organisation. Now it is a matter of minutes, without the need for paper to be moved around. In 1990 we had nine Fokker 50s and 12 people to manage the engineering processes. Now, the fleet has grown to 81 Bombardier CRJs and Avro Regional Jets, and we manage the engineering on these fleets with about 28 people. We selected SAP after looking for a system and viewing other specialist programmes. The very tight integration to the spares/logistic modules, but also to the SAP finance and controlling modules, is another advantage. We went through heavy customisation of SAP to make it work for an airline process. We had a lot of input and help from Lufthansa Systems to modify how the software works. Now we are on SAP Aerospace and Defence Version 4.6C and plan to migrate to 5.0 in 2007 when it is available. We have been live for about a year and the main engineering benefits are in control, visibility and reduction in overhead costs for managing the engineering process."

Comments Fleer, "Our latest customer is Thai Airways, which will join Asiana as an SAP A&D customer."

MIRO Technologies' AuRA system allows engineers to enter all the details about ADs/SBs and internal EOs, including the authorisation of task cards to control work instructions and details such as parts, tools and the resources required.

Bringing it together

Many software vendors' products make a conscious split between external documents and internal Technical Orders (TOs) or Engineering Orders (EOs) to facilitate management of various regulator regimes. This avoids duplication of work when related change requests come from different sources, but relate to the same basic need for engineering change. One example is MIRO Technologies' AuRA product. "The AuRA EO management module provides a comprehensive solution for effectively managing all aspects associated with external and internal change directives," says Mark Ogren, vice president of sales and marketing at MIRO Technologies.

"Ease-of-use is a key strength of AuRA. The initial phase of the process is to log the external reference document into the AuRA engineering library function. We can also upload the electronic documents associated with the change request, and make an immediate note of any non-applicability, including the reason for this. For example, if we know that it does not apply to our fleet, or we have already incorporated the change, either with another modification, or because our aircraft have already had the modification done, we immediately mark it on the library screen. This means that we do not need to waste further time entering redundant data. Once we launch the change into the internal airline departments for analysis, we flow into an integrated desktop that is the 'control centre' for all EO actions, bringing all the required information to the user in one single place. AuRA has a Wizard function to guide users through an initiation process for internal numbering and referencing, which is one of the trickier issues airlines face in this area. Rather than just letting the user enter a free-format reference that is prone to error, the user is guided through a particular reference that is controlled by the AuRA system. Once the basic EO information has been entered, the EO can be designated to associate with other EOs, and the user can assign or create Task/Work Order information and assign the applicability by Model and serial number. Each of these functions is accessible directly from tabs or push buttons located on the screen. AuRA will

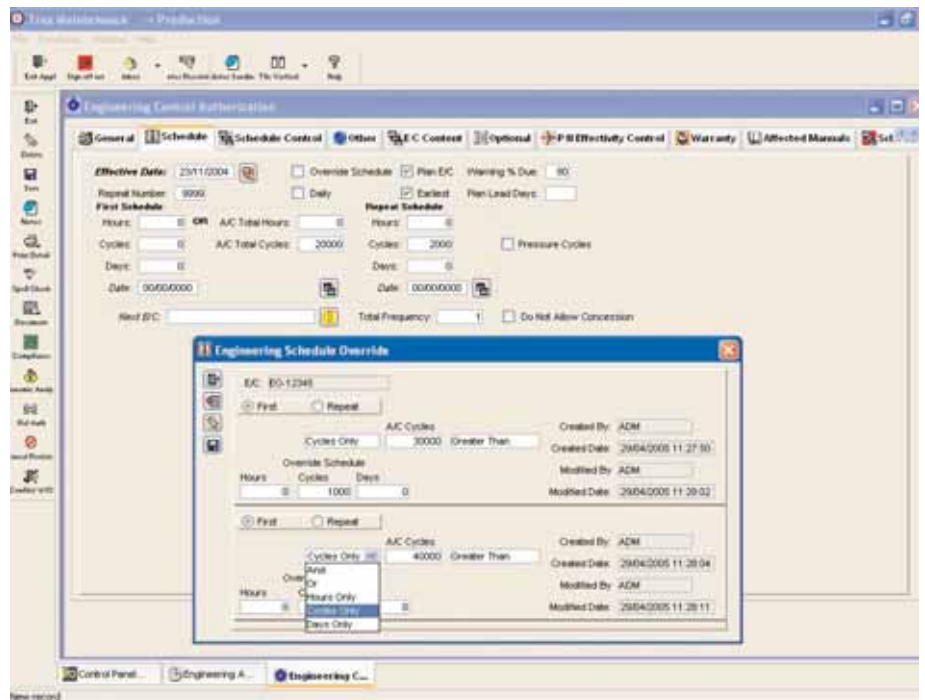
Planning of engineering changes is an important aspect of the change management process. TRAX Software includes a detailed and sophisticated planning tool that can manage multiple thresholds and recurring interval types.

immediately provide a pick list of all parts or aircraft affected by the change. This includes parts installed, in stock, in the repair loop or out on loan. It will also stay active, proactively looking for new parts as they are received into inventory to check for AD/SB status. AuRA also enables an airline to decide how to comply with a multi-part modification. AuRA links all the AD/SB part requirements, but only activates the particular way the airline wished to comply. For example, the airline may incorporate a part modification on only three out of 15 aircraft. It may accomplish a visual inspection every 500 flight hours until the part modification is made on the other 12 aircraft. Economics plays a part in the decision and AuRA can support the economic justification of a particular course of action, helping Chief Financial Officers become more involved in the whole process.”

While the process of building the data in the MRO software is an important part of the control process, engineering departments also need to produce the paperwork and forms for the maintenance staff to carry out the work. This involves defining the tasks, building the Job Instruction Cards and sign-off cards, and the TO itself.

“The TO can also be made in AuRA,” says Ogren. “AuRA holds the job card information in what is known as a default work order, which defines the work to be done for the EO. Work order steps, labour estimates, cost of parts and support equipment are all defined here by the user. The default work order can also store additional default values for model, Illustrated Parts Catalogue (IPC), capacity planning, skill types and quality assurance requirements.”

Other software vendors take a different path, providing key functionality for engineering control, but leaving parts of the process as manual steps. “There are two main parts to the initial evaluation phase,” says Dick Wallis, vice president of sales at Ultramain (formerly SSU). “First there is the technical stage. Does this change affect our fleet? Is it mandatory? Do we need to do anything or is it for information only?,” explains Wallis. “Then there is the commercial stage. What is the financial impact? Is there a cost-benefit case for non-mandatory modifications? Should we embody the modification if we are close to returning



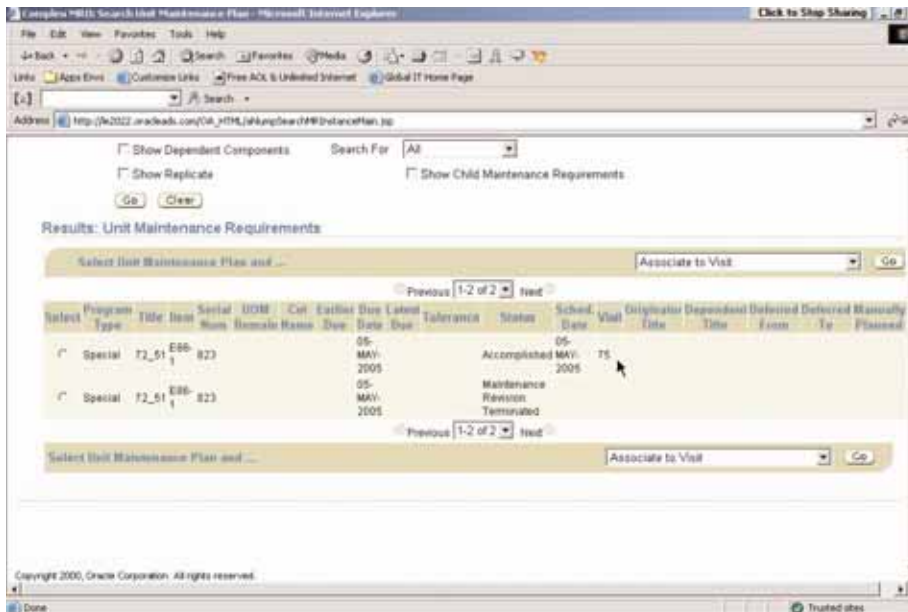
the aircraft? What are the lease return conditions? Finally, is there a marketing benefit? Does it improve the customer experience on board the aircraft?”

Wallis comments that this is done outside of the Ultramain software, normally with e-mails, meetings and MS Word documents and MS Excel spreadsheets. Having decided there is something to be done, the Ultramain system can handle the process from creating the TO to reporting accomplishment. “In Ultramain, the user creates a ‘special’ maintenance requirement, but it is essentially like any other maintenance task. We just tag it with a special identifier. From here we can identify resource requirements, parts needed, time spans and hence total costs,” explains Wallis. “Ultramain can plan an incorporation of the modification and deal with either aircraft mods or component mods. By re-using the same creation and planning tools in the software, we make it easier for the user to learn the system. The TO can be tracked and compliance is recorded as part of the normal maintenance execution.” In addition to the creation of the TO details in Ultramain, the instruction cards can be imported digitally and produced in MS Word or Adobe PDF format. Some enhancements are planned for the product to improve the functionality further in the area of multi-part mods and compliance reporting.

Chris Reed, managing director at TRAX explains the approach his company takes. “We developed a lot of the engineering functionality with United Airlines. We have incorporated an extensive workflow capability in the product to assist the authorisation process for any engineering change request, whether internal or external.

Indeed different documents, like ADs or SBs will need to follow a different signature route. We use instant messaging inside the product to send alerts to people in the chain of authorisation. We can load in the documents digitally, either downloaded from websites or CDs, or scanned from hardcopy, and that is the start of the process. We can link several documents together, such as related SBs and ADs at this stage. This is important because most times a change will progress from a service letter to an SB and then to an AD, or indeed the AD will only specify the change needed, not how it is to be effected. We also have a nice feature to take account of oddities from OEMs, such as the Airbus ‘fatigue index’ that is periodically issued to adjust intervals on certain inspections, based upon aircraft pressure cycles. Inside the software we can record all the relevant information from the AD or SB, including detailed task instructions, from which we can make the job instruction card, the resource requirements, the tooling and so on. We use Adobe Framemaker to produce the required documentation like job cards, with pre-made templates and layouts. The same process is used for updates to any engineering document, like revisions to the Aircraft Maintenance Manual (AMM). When the change requirement is entered and authorised, from a planning perspective, we can immediately see all the affected aircraft or components. These can be planned individually or left for the maintenance planner to deal with, together with all the other maintenance requirements. They can be linked to major maintenance activities such as a C check.”

TRAX can also manage customer data for third-party MRO users, and part



and labour margins can be entered to be added to the final invoice for a certain modification embodiment. This is an important feature for ensuring profitable management of a maintenance shop. Ease of use remains an important factor in this product as with others. There is a standard set of icons displayed to the user, and menu functions are available on a tree-structure for TRAX users to click on. There is a logical flow of data entry into the system. Forms contain many fields which indicate mandatory and non-mandatory requirements. Fields with look-ups have an icon beside them to provide push-button access to reference data. All of the necessary data can be entered by engineering into the database, including details on required personnel, skill types, recommended span times, tooling, recommended work centres, parts, kits, tooling and special sign-off needs. One very powerful feature of the system is the ability to upload the OEM data and import directly from this various AMM requirements into the task information. Linking to the raw Standard Graphical Markup Language (SGML) also allows the user to browse the OEM data directly.

Dealing with complexity

Oracle is one of the new vendors that is investing in software development to complete a product that has been in the making for a number of years. Close to completion, the product has a number of advanced features that have been designed to accommodate the complexity facing airlines today. Utilising many of the features of the Oracle database technology, the Oracle complex MRO (cMRO) application makes extensive use of workflow. "From the point of receipt engineering changes are managed electronically," says Hannes Sandmeier, senior director development of complex

MRO and depot repair at Oracle. "The user can plan a route for approval electronically to the change request, and scan or upload documents into the system. From this a maintenance requirement or technical order is generated. This will contain the source, the AD for example, and the references, such as the SB. From this Engineering will determine applicability, and whether it applies to a component, higher assembly or aircraft. Indeed the change may apply to a product class node or position on a structure (see *IT strategies for aircraft configuration management, Aircraft Commerce, February/March 2005, page 47*). Using the cMRO configuration management functionality, we can identify a specific serial range, or indeed a specific type of aircraft, such as an ETOPS model or long-haul aircraft. Next the user enters information about the engineering change, in terms of accomplishment either as a date or as a count. cMRO will then list all affected components, whether inside or outside the organisation. Engineering can then create what Oracle refers to as a 'route'. This is the equivalent of a taskcard, with header information, and specific data such as resources. These skills data can be defined for each country where the work may take place, in case there are different local regulations. The final step is to build a taskcard. We are building an XML publisher to output the cards as PDF, MS Word or MS Excel. We can establish a technical sequence of the modification for heavy visits, so that complex tasks can be ordered properly. Having completed this step we can move to the Unit Maintenance Plan module so we can plan the incorporation for each affected aircraft."

Planning is key

One of the critical tasks for good

The Oracle cMRO application allows engineering to track, on-line, the embodiment status of any engineering change. ADs/SBs can be linked to other scheduled maintenance inspections or heavy maintenance visits.

economic control of engineering change is planning, which needs to be comprehensive and integrated to be effective. What this means is that data on affected aircraft, the due dates for each tail, and the availability of parts, kits and people to accomplish the task need to be available dynamically and in real time. The ADs and SBs need to be interwoven into the normal maintenance schedule of the aircraft. The software also needs to inform and warn Engineering when critical or mandatory tasks are falling due. Different software vendors offer different levels of tools to assist this process. Some vendors use third-party planning software tools to support their products' capabilities. Some offer 'quick-look' facilities. For example Oracle offers a stand-alone JAVA applet. "This can be launched out of the cMRO product," comments Sandmeier. "It takes the planning data and presents it to the user in a Gantt chart, similar to MS Project. The planner can then make decisions upon timing and schedule of tasks, if the change is marked as 'soft'. If it is already locked in as a 'hard' schedule then the planner has no choice. For each tail number, we can take the scheduled flight plan for each individual aircraft and project forward due dates for tasks very accurately tail-by-tail. The flight schedule is imported through our public API for any aircraft scheduling tool."

One of the most comprehensive capabilities available from software vendors comes from relative newcomer RAMCO in India. RAMCO shares a common approach, upfront in the process, with many other vendors, in logging external documents from regulators and OEMs as external requirements. These can be linked in a sophisticated way to other requirements and documents, for example if an SB has to be accomplished concurrently with another SB or AD. In this way RAMCO can also cater for modification with sub-parts that allow the airline to choose the compliance method. RAMCO also allows Engineering to record an alternative means of compliance, which might dictate that all or some changes need to be accomplished in order to achieve equivalence. The software can also record that certain maintenance actions, a change of part number for example, can terminate a recurring AD inspection requirement. Any internal documents that

RAMCO includes an extremely useful feature to support the sometimes complex engineering change process. Mechanics can request support, on-line, or ask detailed engineering questions, and all this engineering support advice is saved in the central RAMCO database for future analysis and troubleshooting.

are affected by the change can also be noted, such as AMM updates. RAMCO goes further in the support of the evaluation phase of a modification. "This starts with the establishment of a Modification Committee Meeting (MCM) electronically", says Namrata Ahuja, UK sales manager at RAMCO. "Now the airline can schedule, record outcomes and re-direct change requests as a result of the MCM. A good example is a mandatory modification. The airline may decide during an MCM that it needs more time to accomplish the modification, or that it will go for fleet sampling at this stage. All of these details can be recorded and communicated to the rest of the airline. We also have a comprehensive cost-benefit planning tool, that allows the MCM to rationalise the RoI for a modification programme, and to accurately assess the financial benefits. More importantly the rationale for incorporating a non-mandatory SB can be recorded, in case in future a de-modification decision is made and the RoI needs to be revisited. This is ideal for many of our larger customers like Indian Airlines."

From the evaluation phase a Maintenance Change Request (MCR) is raised within the RAMCO system. This can be for information only, or be further linked to one or more Engineering Orders (EOs). The benefit of this structure is that the RAMCO application can handle a high degree of complexity in the process, such as multi-part ADs that can be broken into different subparts, or a change that has subtle differences across variants of aircraft. One example is a fleet of A320 and A321 aircraft where much of the change is common, but with some model dependencies. The EO is built with all the necessary information about the task, down to individual step level, including resource and part data. Task and job instruction cards can be printed using the XML publishing feature of the software. One very interesting feature relates to part control. If the modification brings on a new part in the IPC, the RAMCO application will automatically create a request to add the part number to the master IPC database within the software, and create a link to the EO that authorises that change. E-mail is used to alert users to the request. They simply then review the request and add the

additional data about the part to finally bring it into the system. The system also has a comprehensive set of tools for managing more complex change requests, such as Fleet Campaign Directives, which need a different management process to be controlled properly.

Spreading the word

A final feature worth noting in RAMCO is the Engineering Service Request (ESR). This is helpful not only during an EO embodiment, where new or potentially one-time activities are being undertaken, but indeed at any time that maintenance mechanics need expert guidance from engineering. The RAMCO system enables anyone to raise an ESR, as shown (*see picture, this page*).

It captures all aspects of the request into the central database and makes a work queue for the engineering department to respond. Once they have reviewed the request, their advice can be documented on-line and accessed not only by the original mechanic, but also by anyone else who may need similar advice. Since it is in the database, it means that it can be used for research and to assist in future troubleshooting. "The ESR feature is used by our customers to save time and money, but also to ensure the highest quality of engineering advice is shared around the organisation," comments Ahuja from RAMCO. "It is a good example of how deep our functionality is and how quickly we can respond to specific organisational needs using our VirtualWorks software framework."

Reporting compliance

The final piece in the engineering

change management jigsaw is the reporting of compliance out to the regulator. As hinted by Frost from TNT Airways, this is crucial in maintaining a good working relationship with a body of people who have the power to close down airline operations. Most software vendors have either 'pre-canned' on-line enquiries or reports that can be run to support this step in the process. TRAX and MIRO seem to have the most comprehensive 'canned' off-the-shelf reports, which can be customised and modified.

Summary

Most of the integrated MRO software now available has the basic capabilities to manage the daunting task of engineering change. Control and visibility are paramount, as is the ability to create the required technical documentation to accomplish the modifications needed. One of the keys, however, is the integrated nature of the applications. It is important that once the data on a particular change are entered into the database, the engineering department will be presented with a list of affected parts or equipment, not just at the point of data entry, but continuously during the period that the AD or SB applies. Again, most vendors have this. Where some vendors, in particular RAMCO and TRAX, go further is to add sophisticated tools to assist in the decision-making process, especially economic analysis of non-mandatory changes, electronic communication of change requirements, and the feedback of inevitable requests for further guidance during the embodiment process. RAMCO impresses most in this latter area. **AC**