The repair of sophisticated components and engines involves multiple activities and so requires critical path analysis to streamline and shorten the process. Various software vendors have developed new systems for this purpose, and customers are enjoying the benefits.

Software to streamline repair shop processes

Providing parts and labour at the right time and place is a critical part of good backshop management for any maintenance and repair operations (MRO) provider. Organising and controlling work and meeting return-to-customer dates can be a complex task. The capability of MRO software systems to handle the off-wing repair and overhaul challenge is analysed here.

Backshop requirements

The requirements and challenges of backshop management differ greatly from aircraft line and base maintenance tasks. Although the two types of maintenance have some requirements in common, even the best software systems for aircraft daily operations management and hangar maintenance struggle to cope with the different environment and management priorities of a backshop, unless they have specific additional functionality.

A main player in the repair system domain is Avexus of California. With a number of third-party repair customers, as well as airlines, Avexus's asset management and operations (AMO) solution addresses some of the specific requirements of the shop environment. "There are two ways to deal with an engine repair or overhaul," explains Paul Dibble, business development director at Avexus. "The first is an 'in series' approach, where the engine assembly will be torn down and all the parts are kept together. We will work on the engine as a series of repair steps. The alternative is a 'parallel' process, where we tear the engine down to a module level, and then manage the parts separately. This method is usually more time-efficient.

"In both cases, when the engine first arrives, whether it already has a detailed workscope identified or not, it must be stripped down and 'sentenced'," continues Dibble. "A decision is therefore reached, after the initial inspection, about the workscope required. Usually, there are well-defined repair steps or routings through the shop, depending upon the findings of the initial inspection. These routings are the paths the different modules and assemblies will take as they go through various stages of the shop. Our system can set up these routings, so that when an inspection finding is entered, the system will automatically generate a work order and a routing tag for the module. For example, the induction inspection may yield a category A finding on a set of compressor blades in the compressor module. The system will have an embodied cause-effect relationship for this finding and will create a work order for the blade set, to have a minor repair carried out in accordance with the original equipment manufacturer (OEM) repair scheme. The blade set will have a routing tag to the compressor shop auto-created, and the blade shop will see that it now has a set of compressor blades available in a queue, with the relevant technical references attached for the repair scheme. AMO can also handle the need for parts to be manufactured, for example from sheet metal or welded from a set of piece-parts, to a manufacturer's specification. Most aviation MRO software systems cannot handle this process."

Just-in-time management

Avexus has been in the market for a number of years and has amassed a substantial customer base, including Pratt & Whitney Canada for small turboprop gas turbine MRO. P&WC has become more of a collaborative partner than a customer, acting as a development testing ground for new functionality. Messier-Bugatti, part of the SAFRAN group, is another customer that uses Avexus for shop management.

"Just-in-time (JIT) management is key to working in a shop environment," continues Dibble. "The due-out date for the assembly or the component drives the scheduling and organising of each individual work order to repair, refurbish or reassemble components. We only want new or repaired parts delivered back when they are needed, which reduces costs and streamlines the repair process. Customers are different, however. Some will insist that only their parts are repaired or re-installed in their engine, so the system must manage this constraint, and track all parts. The engine's technical logbook must be carefully updated. This is an important aspect of our product that differs from traditional enterprise resource planning (ERP) systems.

"Other customers do not care which material is used, as long as they get an engine back to a particular modification standard and with a certain amount of hard life remaining on life-limited parts (LLPs)," continues Dibble. "Here it is important to track and monitor the modification standard of key components being issued to a job, and to enable quick economic decisions to be made on a repair-or-replace scenario for a particular job. Again, managing technical records is complex and must be handled carefully. It becomes more like a core exchange programme, where the customer provides a timed-out engine, and gets a working one back in less time than waiting for its parts to be repaired would take."

Dibble adds that the other key to working in a shop environment is planning for, and the visibility of, unforeseen delays, and their consequences. AMO will immediately show if a work order is delayed past its expected due date, and the effect this will

have on other related work. The users can change a routing 'on-the-fly', or indeed create a new repair route for the components, all of which will be reflected back into the master plan. Alerts can be sent by e-mail, pager or text message to management staff when delays occur on the critical path.

While Avexus's AMO has no in-built project planning capability, or Gantt charting, it can be linked to a third-party tool, such as Primavera, for advanced scheduling and analysis. Another option is the use of MS Project, but while this is appealing in terms of usability and cost, it can be a hindrance because it lacks the necessary capability for large project management of concurrent activities, as each step is displayed on a separate line.

ERP versus MRO

The similarity of the shop process to a manufacturing process, and the depth of financial control desired by some, means that the more general ERP systems like SAP find a more natural home than in the aircraft maintenance hangar, particularly in engine overhaul facilities. Rolls-Royce (RR) is an example of a large engine overhauler that is now reaping the rewards of opting for large-scale SAP implementation in the late 1990s, using EDS, to which RR had outsourced all its IT functions. One reason for selecting SAP was its capacity for implemented repair and overhaul functionality. This could be linked back to the ERP side for engine manufacturing, and into a customer relationship management (CRM) capability to provide a more integrated approach to managing the whole business life cycle. This aspect makes the OEM a special case where general, and more expensive, ERP solutions are probably the right option.

Other systems that stem from ERP have been more specifically adapted for the aerospace market. Sweden's IFS has been successful in deploying ERP-adapted solutions for the shop environment. IFS signed a deal with GE Aircraft Engines (GEAE) in 2001 to develop the Spectra solution, which was rolled out internally in GEAE overhaul shops. Although initially offered as a joint development to the rest of the world, it has disappeared from the market place.

Other facilities, like Finnair Technical Services, have been implementing IFS within their MRO facilities, including their engine shops. The initial feedback is good, indicating that there still seems to be a place for the generalist in some of the larger backshop projects.

Replacing a number of legacy systems, the IFS application will control all processes related to airframe maintenance, engine overhaul, and system and component repair in one integrated solution. The contract, covering licences and implementation services, is valued at EUR 6.2 million.

"The particular advantages we see in IFS Applications are its flexibility and comprehensive functionality," says Jarmo Vilenius, senior vice president of Finnair Technical Services. "The system can easily be adapted to our specific requirements, and the intuitive user interface makes it easy to use. In addition, our decision was greatly influenced by IFS's strong aviation expertise. We will get a system that is tailored to the needs of our industry, and that provides industry-specific technical support."

Other ERP-based solutions include Intentia's MOVEX solution, the latest version of which is being re-installed by SAS Technical Services (STS) for all of its third-party MRO facilities. Mats Wehlin, the CIO of STS, comments: "We have been co-operating with Intentia for a long time on logistics and material supplies. The implementation of the latest version of Intentia Application Suite at our subsidiary Braathens Technical Services has shown that the new version offers the functionality needed, and is also a technical platform that will support our current rapid pace of development. It was therefore logical to choose the Intentia MRO solution as a common platform for the group."

STS will focus on customer orders when it comes to managing the business with the new system. The integrated flow of information in Intentia Application Suite gives the customer greater accuracy over what has been ordered, performed, delivered and invoiced. Orders from customers and orders to suppliers will be placed electronically on their systems and even on e-marketplaces like AeroXchange. "Ordering, planning and follow-up can be more closely linked, which will enable us to use our capacity better so that we can handle the low margins of the market, while maintaining profitability. We will therefore be able to handle more customers," says Hans Lindberg, chief financial officer at STS.

"What ERP systems lack is a strong configuration management tool for assemblies where parts are repaired or modified," says Dibble. "For example, we are working with Pratt & Whitney Canada on providing automated support for decisions on the workscope, depending on whether it is a low- or high-time part. Also, the process for robbery or cannibalisation in a repair shop is trickier than a straightforward production build line. These are things that an ERP-based system will find hard to cope with, unless it is seriously customised."

An ERP-based software package may work for those with a large enough shop, deep enough pockets, and enough time to spend on customising the solution. The wisdom of this approach remains to be seen, however, for the majority of shop environments when there are so many good aviation-specific solutions.

Rebuilding

To reinforce this view of the specific requirements of the shop environment, supplier Swiss Aviation Software, which produces the AMOS suite, has just re-engineered its shop module over the past six months, taking extensive input from its customer base. It claims that it now has a highly scalable component maintenance (CM) solution that will cover facilities both large and small. A small shop will only make limited use of the module, while an engine shop will fully utilise the new functionality.

It is now also a flexible solution. The CM module can be used as a standalone system or as an integrated solution with the rest of the AMOS application which offers a great number of additional possibilities.

Finally, the forecast of repairs is graphically represented and work progress can be easily monitored. This is a key difference from most other software vendors' products, which tend to opt for an interface to another tool like MS Project.

"A big advantage of the CM module in AMOS is its scalability regarding planning, task templates and processed parts," claims Claudia Weiss-Giessler, vice president of marketing for Swiss Aviation Software. "Managing the shops and repair activity requires different tools to support the decision-making process with the aim of constantly reviewing and improving the work process. The extent of planning can depend on the duration, scope and kind of repair. Short and simple repairs will normally require less planning time than more complicated tasks. The planning of a repair in CM can be minimal, rough or detailed, taking manpower, tool availability and work-centre availability into account. The task templates can be defined singly, in a hierarchical structure, and can then be grouped into defined work bundles, allowing the given tasks to be reflected appropriately in the stored templates."

"Processed parts vary from a single part to a whole engine tree, which is compared to a master reference tree to provide configuration management and validation of data entry," continues Weiss-Giessler. "Scalability gives each individual shop the option to use CM in a manner that suits its specific needs. CM also has entry points to the AMOS 'Workflow System' offering the possibility to define a workflow for an event triggered by CM. For example if a repair is completed for a part needed in a higher level repair, the system could send an e-mail, fax or text message to the lead mechanic. These workflows are highly customisable. Documents and requirements can be directly added as tasks to a repair. They can then be

performed during the closing of the repair. The AMOS 'Financial Module' provides a detailed invoice based on the data entered in the CM module."

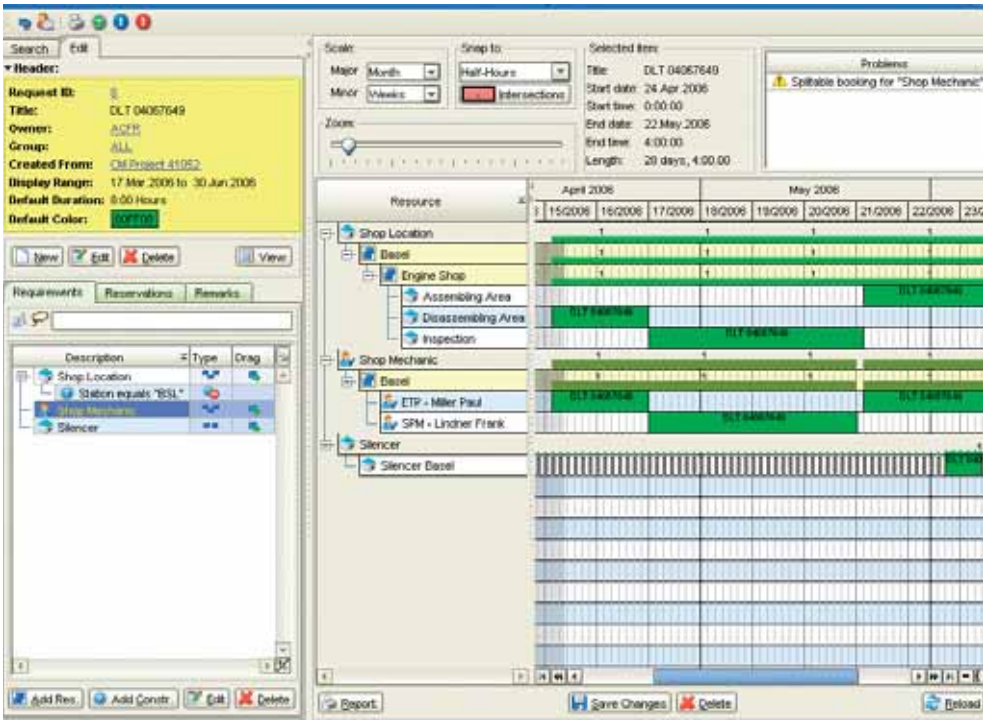
AMOS also differs in the way that work in progress is displayed and managed. During project execution the projects can be monitored more easily due to the graphical representation of the projects on the forecast screen, providing live information on the repair progress. This information will also be available after closing the repair for review purposes. Various reports, covering performed work, and inspected or used parts, are available to document the executed work. Upon completion of the repair, the release documents, for example the EASA form 1 or FAA 8130, will be presented pre-filled and ready for printing.

AMOS also employs the 'enter-once-use-many-times' principle, as do most software vendors, using master templates extensively throughout the system to cut down on administrative overheads for repetitive data entry. For example, tasks can be defined to represent a logical work step. Required parts and measurements can be added to these tasks. The tasks themselves can be grouped together as necessary, and have additional attributes, such as duration or invoicing information. Different groups of tasks can then be joined to form a work bundle which defines, for example, an overhaul of an engine. These work bundles can be linked to parts, shops, or removal reasons to enable AMOS to automatically propose or assign them to repairs. Analysis of the new CM module does not make clear the strength or depth of the initial estimating, quotation and contracting part of the process. This is essential for third-party facilities trying to use the capability.

Quoting and contracting

An important aspect for any shop taking in work from third parties is the initial quotation and contract negotiation on terms and conditions. The initial workscope will usually be defined at this stage as well. Russell-Adams (RAL), a UK-based software company that offers MRO software, electronic flight bags (EFBs) and flight operations software, is making an impact on the market place. "Quotation management, workscope development and contract agreement are the starting points for our system for a third-party workshop implementation," says Richard Vorias, marketing director at RAL. "It is important to establish terms and conditions, labour rates, part costs for consumables, and how rotables will be treated. For example, thresholds should be set for repair costs that will need sign-off by the customer. These data will all be important control criteria for the rest of the actual repair and overhaul process to run smoothly."

As with most other software systems, RAL uses the concept of templates that can be set up for engines or assemblies. These will describe the allowable configurations, with part number families by position, and maintenance items, or work breakdown structures, against the assembly or the position. Essentially it will describe the way the OEM built the engine. "The template data can be set up manually, and re-used over and over again by the shop against known engine types for example," continues Vorias. "The RAL solution can also import the data into the system from OEM data sources, to make this process faster and simpler. Once the reference data are established, the engine arrives and is inducted into the shop. This involves a receiving and quality process, where paperwork is checked. Technical logbook



AMOS has been re-designed to improve the component maintenance module functionality.

data are then entered into the system, including actual installed part numbers and serial numbers and the corresponding 8130/form 1 data relating to lives. The first task is then the initial strip and disposition of parts, when the workscope is refined and finally agreed, once the actual condition of the engine has been established. Unfortunately for the customer, this is usually when additional work is discovered that must be added to the original workscope. At this stage work orders are created for individual assembly or component repairs, and are sent through the shop. The work order will contain the parts list, tooling, and manpower requirements for each task.

The task cards are also held within the RAL system. Usually they are held as MS Word templates, with tags or hyperlinks to other technical documents such as OEM job instructions and graphics. These are then used to print the work packs for each work centre. The work order comprises live data, connected to the shopfloor data collection system, and is used to look at the overall schedule of the repair through the shop. As parts or assemblies move through the shop, work is carried out.

The mechanics will need parts to carry out the work, or to send a part for outside repair. Requisitions are raised in the RAL system, with many different annotations to indicate what is being requested. For example, there may be core exchange requisitions, and the terms and conditions for this exchange are detailed in the original contract module. Sub-work orders can generate internal repair work requirements. At any point, work can be generated in a quote status, awaiting a customer's approval, which is inevitable, especially for complex assemblies like engines.

The overall scheduling capability of the RAL system is handled by the work order system, and MS Project is used to visualise this on a timeline. It is currently a one-way interface, pushing data out to MS Project, but can be two-way if the enterprise edition of MS Project is purchased. "It is simple to refresh the MS Project view of the work schedule so one-way is fine," says Vorias. "The important point is that it is real-time and up-to-date work recording, so the status of a task is immediately visible and its effect on the critical path can be assessed. In fact, we deploy on wireless equipment, like the Panasonic Toughbook CF18 tablet, to aid point-of-maintenance recording. The system has electronic signature capability. We believe the critical part about our system, however, is its usability. You can have all the data fields you can think of in the world, but if the screen layouts are cluttered, are not intuitive or workflow is muddled, people will not use the application. Our shop customers include Saab Nyge Aero, Tenix in Australia, which overhauls Honeywell TPE-331 and P&WC PT-6A engines, and SR Technics Spain, which handles wheels and brakes. Indeed, we are adding feed from the P&W engine health monitoring system as a feature for one of customers. The RAL system has undergone some significant improvements and we now feel that we are one of the top solutions on the market."

Neat features

Among the other vendors, there are some nice features present for shop maintenance. Ultramain, previously SSU, offers a complete suite of tools including shop assembly management. The fundamental part of the Ultramain system is the configuration management tool *(see IT strategies for aircraft configuration management, Aircraft Commerce February/March 2005, page 53).* Ultramain takes this one stage further in the shop environment, and uses the logical configuration template to check the inventory available and show the planner which allowable configurations could be built from parts in stock, and which would delay the build process. The planner can look at the engine as a tree structure and colour code red those positions where particular part or dash numbers are out of stock. This use of technology is interesting and could be useful in some circumstances, particularly if the engine shop was part of the overall maintenance organisation.

Of the other vendors, MXi's Maintenix product is used by some large shops, both civil and military, and uses the Manugistics material systems to augment the functionality. Customers include KLM and some large military organisations. The flexible JAVA technology of Maintenix makes it very easy to use in shop environments. TRAX, Cimber and MIRO Technologies also have customers that use their shop modules, and offer a similar range of functionality to those that have been reviewed.

The devil is in the detail

The shop environment requires some specifics in the software to run efficiently. Most MRO software vendors claim to offer some shop management capabilities, but some of these are so embedded with the other aircraft-specific functionality that they cannot be deployed separately. Quotation, workscope management and contracting capability are important to efficiently control the financial aspects of the shop process. Most organisations will not be large enough to justify the level of investment in IT technology required for an ERP-based solution, and will probably therefore need to look at the specialist MRO software vendors. It is worth looking carefully at the real capabilities on offer, however, to ensure that they are able to cope. AC