Poor utilisation of maintenance & repair intervals is one element where the efficiency of aircraft maintenance could be improved. Geoff Hughes analyses the systems available that allow maintenance planners to optimise the timing of maintenance tasks.

Right place, right time: The art of short- & long-term maintenance planning

Aircraft maintenance programmes are becoming more sophisticated, and provide more flexibility for maintenance planners to decide when tasks should be performed. However, this can complicate the task of compiling workscopes for a hangar checks, and makes a compelling case for acquiring an IT system to handle this sophistication.

When the $100 billion that airlines spend each year on aircraft maintenance aircraft is taken into consideration, it is easy to see how good planning can contribute to cost control. Getting maintenance planning wrong can ultimately have disastrous consequences for airlines.

The latest IT vendors and systems, which provide maintenance planners with the tools to do their job better in the short and long term, are reviewed here.

The basics

Regular maintenance and inspections ensure that aircraft are airworthy and prevent component and system failures during operation. There is always a tension within airlines between the need to maximise the availability of aircraft for operations and having sufficient downtime for maintenance. While commercial departments want to maximise aircraft utilisation, maintenance departments need to have the aircraft available in the right locations for reasonable periods of time. Unexpected failures of components or a shortage of parts or mechanics with particular skills and qualifications add to the complexity and stress of planning maintenance.

Many inputs need to be juggled by maintenance planners to produce a workable solution: the flight schedule; the aircraft technical status; material availability; hangar space; mechanics' availability; and the scheduled tasks themselves.

The cost savings derived from efficient maintenance planning, however, can be substantial. Out of a fleet of 20 or 30 aircraft there will always be three or four aircraft in maintenance and out of revenue service. If maintenance planning can be optimised, and hangar time reduced, it might be possible to release one of those aircraft into service and reduce the number down for maintenance to two or three.

When maintenance planning is this efficient, it produces a 'free' aircraft to generate additional capacity and revenue, or reduce the fleet requirement by one. The scope for this level of efficiency is naturally higher with larger fleets.

At a micro level there are still substantial savings to be realised, for example task yield: the actual interval over which the task is accomplished compared to its theoretical allowable interval, expressed as a percentage. Another way to express this is utilisation of the interval for a maintenance task. "Let us take a theoretical inspection task that is carried out every 1,000 flight hours (FH) and costs $20,000 each time," says Paul Dibble, business development director at Avexus. "If an aircraft flies 4,000FH each year, we would perform this task four times a year if we were exactly spot on the maximum interval every time, or if the task yield were 100%. This is a little unrealistic, however. If we are achieving only 80%

yield, then the task would be performed every 800FH, and over the course of a year we would do the task five times: one more than allowed by the maintenance interval. So for one aircraft we would be spending another $20,000 each year for this task alone.

"The lower the task yield the more frequent the maintenance and the higher the cost of maintenance," continues Dibble. "This additional cost per year, just for this single task, is equal to $200,000 for a fleet of 10 aircraft. When all the regular tasks are taken into consideration it is easy to see how good planning can save a lot of money. It is also equally vital for maintenance planning that planners do not mis-time a task and exceed the allowable interval. Grounding the airline for safety reasons can be even more catastrophic. It is a fine line to walk between safety and optimum economy."

Good task reference data

As has already been seen in a previous article examining IT strategies for aircraft configuration management (*see IT strategies for aircraft configuration management, Aircraft Commerce, February/March 2005, page 47*), modelling the maintenance plan from the aircraft maintenance manual (AMM) tasks is the starting point for good planning. All vendors of modern maintenance and repair operations (MRO) software use templates for their AMM reference data. These are held for each aircraft model and component to describe when maintenance is to be done, and whether the driving interval 'clock' will be based on calendar, FH or flight

Maintenance planners have the ability to view maintenance capacity availability at each location across the airline's network, and plan corrective action accordingly. For deferred defects we need to ensure we do not overfly the allowable interval. We push these deferred maintenance items (DMIs) on to what we call an active task list. The planner gets live updates to these active tasks and can see instantly if there is a part shortage that will affect the completion of the task.

"For longer-term planning, the task yield is usually the driving factor," continues Dibble. "We want to get as close to the allowable interval as possible, but still fit in with the flying schedule for each aircraft. We can view the active task list, or list of due items, and see what work is falling due in a date range. We can play 'what-if' scenarios with these data. For example, we can accelerate the average utilisation rate to simulate an increase in flying for the aircraft. The resultant change of due dates for tasks can then be evaluated by the planner."

Another neat feature in the Avexus AMO system is the ability to take a fleet view of a particular maintenance task group, such as heavy checks. "We can ask AMO to auto-create the work packages, maximising task yield and make optimum use of space in the hangar over a long time horizon," comments Dibble. "AMO can even auto-generate a maintenance budget for five years, based upon a certain flying time for the fleet." While this is functionally possible, airlines need to be careful about letting the computer take over too much of the process. It still needs a large input of human experience and complex logic that most, if not all, systems are incapable of emulating yet.

cycles, or indeed a combination of several criteria. These templates hold the task details along with the default material, tool and manpower requirements to complete the task.

Most available systems also have the ability to establish complex inter-relationships between tasks that will ease the planner's job when deciding how to group tasks together. This is becoming ever more important as airlines move towards equalised maintenance programmes, and away from more old-fashioned block letter checks. The advantage here is that individual tasks within a block, which have different intervals, can be scheduled closer to their individual maximum allowable interval, thereby increasing their task yield. There is some variation between vendors' systems as to how well they handle this detailed complexity, and how easy or difficult they make life for the planner. It is an area that should be explored thoroughly during an evaluation of a new system. It is easy to gloss over this in a

demonstration only to be caught out during or after implementation.

Real-time operational data

The Avexus AMO product provides an example of the benefits of an integrated, real-time feed of operational data as the next step in good planning. "We provide the same interface and functionality for planners and short-term maintenance controllers for both long- and short-term planning," says Dibble. "This eases training and documentation for the software. For short-term planning, however, the key is to get real-time operational data for each flight and marry this with the initiation and completion of non-routine maintenance, generated during the course of the day. The operational data come as a direct feed from the aircraft crew and reporting system (ACARS) on the aircraft. As the aircraft completes the flight, the FH and block hours (BH) are data-linked to the ground and into Avexus's AMO system.

Graphical views & planning

"Short-term planning is mostly about flights, where the aircraft is at present and where it will be next, and what deferred maintenance it is carrying," says Chris Reed, managing director of Trax. "Our system can map the flight schedule into our Maintenance Timeline screen. This is the main Maintenance Control screen used by the short-term planners and shows ground time, time to departure and a list of defects, aircraft-by-aircraft. We developed this for Comair. It also enables automatic e-mail notification for different categories of minimum equipment list (MEL) deferrals which have a pre-defined time expiry. It is important that the display is clean and easy to use in what is a highly time-pressured environment."

"Long-term planning is more about balancing requirements with capabilities, both in terms of physical space, if the airline carries out its own maintenance, and in terms of resources such as parts and labour. The first part of the process is

The MXi 5-day planner is ideal for maintenance control departments.

to lay out the capacity constraints, at a high level, i.e., both slots or bay space in the hangar and the available manpower for an airline that does its own hangar maintenance. In our system we can set up geographical locations, and identify bays, with specific sizes and capabilities. For example, the aircraft docking for an A320 is very different from that required for an A340. The hangar capacities can be as detailed or as high level as the user likes. Next the planner can go through two levels of planning, but usually in an iterative cycle. First, an aircraft, or a fleet, can be analysed to assess the scheduled maintenance requirement. In our system the tasks will all have default values for the amount of manpower required to complete them. Using our graphical planning board, the planning department can lay out a timeline of individual items, and when they are falling due. These will be colour-coded depending on a series of factors, for example how close to their due date they are. The planner can pick up the task and drop it into the work order that they have created for that hangar input. The system also carries default parts information for each task, so the system will also warn the planner if there is a part shortage against the workscope they have selected. Notes may be added to the planned work order, so that there is a central reference point for why certain tasks are included or not. We use a native Gantt chart graphical tool within our system for ease-of-use, but can export out to MS Project for the next stage, which is production planning. The planning board has a lot of flexibility to assist the planning department. For example, maintenance planners can just select a time-slice, for example next September through to next December, for either a single aircraft, or a fleet, and the tasks falling due in this time window will be displayed. We also have a non-graphical display for planning, which dispenses with the coloured pictures, but displays a lot more textual information. For manpower, this can be planned and matched within the system, or through an interface with a human resource (HR) system. The system holds planned mechanic availability by shift, by day and by week, and this can then be matched

against planned work, with any discrepancies highlighted to the planner. The planner can drill through the data to look at individual conflicts or anomalies."

Software flexibility

For MXi, the visibility and the flexibility of displaying planning data are key for its users. "Maintenix has many views that allow a user to see maintenance due, whether scheduled or unscheduled," says Matt Tobin, vice president of marketing & alliances at MXi. "The planners have a number of tools at their disposal. They can look at maintenance opportunities when an aircraft is scheduled to be on the ground, and examine the possibility of bringing maintenance forward. When putting together the final work package, the planner can see where the aircraft will be and for how long, whether the required parts are available and whether sufficient labour and space are available at the gate or in a hangar.

"There is also a specific view for short-term maintenance control planning," continues Tobin. "We call it the specialised five-day planner, which allows one view that overlays the aircraft's current flight plan and maintenance coming due, scheduled maintenance, MEL deferrals and so on. For long-term maintenance, Maintenix can project scheduled maintenance, allowing the user to see maintenance projections far into the future. Maintenix allows the assignment of forecasted maintenance into work packages, for easier long-term planning and organisation."

Unusually, the long-term planning views are tabular, and are not shown graphically in a Gantt chart. A neat feature of Maintenix is that if maintenance is planned into a particular location, a change in the flight schedule that produces a conflict or problem with the work plan is flagged up to users on screen. So maintenance planning can stay in tune with the changing commercial need to fly planes in real time, without worrying about missing a maintenance task. The system also handles financial planning or budgeting. Maintenix tracks all maintenance costs, both materials and labour. It then associates maintenance activities to cost centres or project codes. With these cost structures and the long-term maintenance forecast, it can help a user develop cost projections. It can then track actual progress and consumption against those budgets, as the long-term plan unfolds.

Quick reaction time

All plans should have the capacity for modification. AMOS, from Swiss Aviation Software, has a new module being released at the end of 2006, as part of the 'Maintenance Forecast' module. It has re-planning and contingency as a key feature. "Upon opening, the maintenance production planner gets all maintenance events at a glance, chronologically sorted by due date according to aircraft utilisation, regardless of the nature of the maintenance events," comments Claudia Weiss-Giessler, vice president of marketing for Swiss Aviation Software. "The planner not only has all relevant information regarding these events, including the availability of parts being
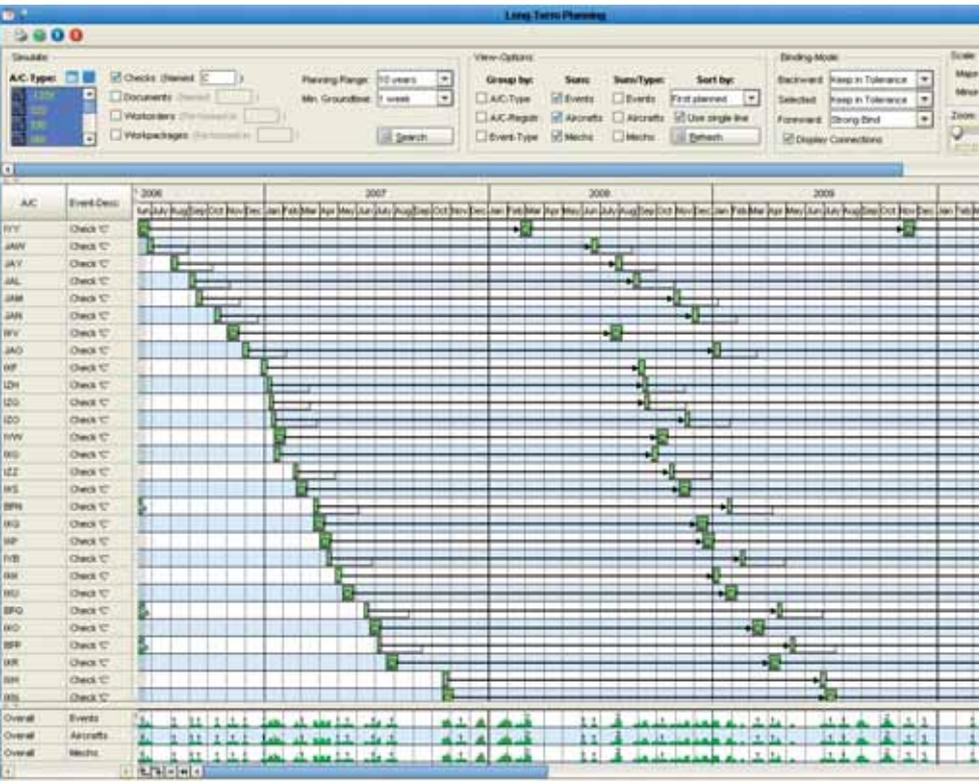
AMOS's integrated long-term planning screen makes it easy to visualise a complete fleet maintenance programme.

checked over all stations, the indication of estimated ground-time and the manpower resources/skills required, but the original files for each maintenance event can be opened to retrieve even more detailed information per event. To further optimise maintenance planning, the company is in the process of embedding into AMOS a full-featured, fully integrated shift-planning and attendance system to increase the efficiency of the planning process. Ultimately, the maintenance planner's skill lies in matching and re-matching a large and dynamic list of maintenance events against a finite set of resources. In order for the planner fulfil this very ambitious task they need a tool that delivers comprehensive information represented in a transparent and concise way. All the functionalities that have been built into, and enhanced in, the AMOS 'Maintenance Planning' module fulfil the ultimate goal of using a single rich source of data to help all those involved in the planning process to trigger the execution of the work package, while keeping all relevant factors in mind. The entrepreneurial balance between maintenance requirements and aircraft utilisation can only be achieved by a system that delivers comprehensive information in a transparent and clear way, and allows for re-planning based upon real-life events. The graphical possibilities of AMOS, due to its advanced technology, have been exploited to the full to increase the efficiency of the planner who, having the right information at a glance, may take the right and anticipatory decisions."

The ERP perspective

Some of the larger enterprise resource planning (ERP) companies are still competing in the aviation MRO market.

"IFS has come from the ERP market space," says Geir Sigve Jøsendal, development director from IFS Norway. "We are not like the big traditional ERP vendors, but we have an expanded functional capability compared with most of the specialist aviation MRO point solutions. One key strength is our technology, and the aviation application is based around user-configurable portals. For short-term planning, we have a maintenance control portal that can display a dynamic, up-to-the-minute status of each aircraft, with the due list of tasks being interleaved with real-time gate information. This allows the short-term planners to monitor deferred maintenance and try to plan rectification in windows of opportunity during the operational day. This is possible because the IFS application has an operational planning module that interfaces with the airline's flight operations system, and downlinks ACARS data into the database to provide this information in an integrated form. As well as having configurable views for maintenance control, the IFS application can also display scorecards or traffic lights, and can be configured to re-colour tasks depending upon business triggers, for example, if a task falls overdue. A separate part of the system, which we call the Event Manager, can also be configured for each customer to perform tasks like sending e-mails or instant messages, or calling mobile telephones,

again depending upon business triggers.

"For remain-overnight (RON) or hangar maintenance, the planning process is obviously different, so we have different tools," continues Jøsendal. "In this case, the customer can choose the traditional client-server environment or the web environment for the IFS application. Again configuration is very open and flexible, with each user having the ability to change and structure their own menus. For medium- to long-term planning, we use a function called the Task Distribution screen. In this concept we have two different status levels for a task: pending for a task due but not scheduled yet into a work package; or running tasks for those already included in some work plan. We use what we term the workshop code to identify the geographic location, and indeed the hangar bay in which we intend to plan the work. The available slot capacity is also managed, in terms of both the physical space and manpower capacity available."

One very nice feature of the IFS system is the ability to provide some automation in the proposal of groups of work that should be done together. Their so-called 'automatic task distribution' function can be used, for example, in engineering when creating a service bulletin (SB) to link its embodiment to a D check. Then when the planners are looking at the next D check, the system will automatically recommend that the SB is scheduled concurrently. The automation extends to other tasks, and to opportunity or conditional tasks that the planner should consider when scheduling a particular type of work, for example, when the engine is removed. A second feature which is becoming ever more important, is the easy ability to take tasks out of a notional block of work, in order to equalise the maintenance load. More airlines, and indeed the OEMs, are trying to move away from the old traditional block letter checks to a more efficient, distributed and equalised plan for inspections, with each task being scheduled separately. While this may be good for economics, it can create a real headache for planning. So the maintenance planners still need a way to pre-define a 'pre-packaged' work group.

If a task is taken out to balance the workload, it cannot be forgotten and must be rescheduled. "The IFS system retains a flag against the normal pre-packaged work group to show that a task is still not completed, and remains so until the task is scheduled," continues Jøsendal. "The pre-packaged work can also have some default or standard non-routine hours loaded against it, based upon the last five times we carried out the same work. When planning the final work package, we use a drag-and-drop window to pick up due tasks and drop them into the package. We do this on a graphical Gantt chart view. Customers using these tools include the Norwegian Air Force and Bristow Helicopters."

The .NET approach

Russell Adams (RAL) is a UK-based vendor that has invested in moving to a .NET application over the last five years, and whose planning capabilities are impressive. "We completely re-wrote our application in 2003," says Gary Smith, operations director at Russell Adams. "We then re-started the development again in 2004 with our second release of what we call our Enterprise version. This incorporated many new features and a completely new data structure. In fact, it is not web-based but a smart client-based application, which provides a much more functionally rich application. For planning, we have different planning boards for line, hangar and engine maintenance.

"The line board interleaves the schedule and the maintenance due list, and can also provide access to engine health data," explains Smith. "New defects are raised and stored just like any other maintenance item, so in the database they are identical to a scheduled task. For heavy check planning, we re-use the same planning functionality, or for third-party maintenance facilities we can import the workscopes from MS Excel. The planners for heavy maintenance will play with the workscope and can use the RAL capacity planning capability, and integrated spares and tooling availability, to decide on the final scope. After the final planning meeting is held to confirm the workscope, the work package is changed from 'planned' to 'open'. The graphical nature of the tool enables the planner to have easy and quick access to all the data needed to make a planning decision. The .NET framework means we have flexibility to adapt and change the screen layout and menu structure, to suit each client."

A nice feature of the .NET environment is the integration with the rest of the MS Office suite. For example, a menu option can be added to link to particular MS Excel tables that a user has

created, from within the very RAL application.

Summary

Good planning can save money and guard against a build-up of DMIs that can eventually ground an aircraft. Bad planning can even ground the whole airline. At the moment most of the MRO software packages have very sophisticated tools to really make a difference to the planners. Some need more scrutiny to ensure they really do handle some of the complexity in such a way as to make the system useful. A combination of usability features, such as colours, graphical layout and drag-and-drop, combined with a good reference backbone for task data, can enable maintenance planning to save millions every year. Some applications have very flexible, graphically-rich user interfaces that help the planners enormously. **AC**