The traditional system of manually planning airframe maintenance checks, and routine and non-routine tasks with printed cards has several inherent inefficiencies. The path to transforming maintenance checks into an electronic proces and the gains in labour efficiency are examined.

Using electronic & paperless maintenance to improve labour efficiency

Maintenance & Engineering (M&E) IT systems offer many benefits, some of which involve improving efficiency and reducing the cost of maintaining an aircraft fleet. A key element relating to maintenance efficiency and cost is the efficiency of mechanics' labour, essentially the percentage of man-hours (MH) that a mechanic is at work and paid for that are actually used for performing maintenance tasks. This affects the cost of maintaining an aircraft for an airline performing its own aircraft maintenance, and affects the cost of providing labour and profit margins for providing maintenance for third-party airline customers.

Use of electronic maintenance systems for planning and performing maintenance can improve efficiency, ultimately leading to a reduction in cost of labour. The steps to transition from a traditional manual and paper-based system to a fully electronic system for planning airframe checks and conducting maintenance, and the related benefits, are examined.

Labour efficiency

The labour cost for aircraft maintenance execution is determined by several factors, and the first group of factors relates to the mechanic. These include their particular licence and skills, which affect hourly rate or basic salary, number of basic hours they are required to work under contract, and rate at which they are paid for overtime work.

Additional elements relate to the maintenance provider, airline or independent maintenance, repair and overhaul (MRO) provider: geographical location; level of education in the locale; number of daily and weekly work shifts; and rates of insurance for employers or employee pension schemes in the locale. Staff facilities, such as catering, training and other amenities, also incur costs.

These all affect the basic cost of a mechanic's annual employment, and so their hourly labour cost. They are added to by other overheads, which increase the overall cost of labour. The main elements relate to supervisor and management staff on the maintenance shop floor, but also to engineers and support personnel.

These issues can be managed to reduce the overall requirement and so effect a reduction in a maintenance provider's overall labour cost per MH. Most factors and elements can be managed by evolving maintenance planning and execution activities from paper-based to fully electronic systems.

"Under a traditional paper-based system, the labour efficiency of mechanics is 45-70% at many independent MRO providers," says Dr Hugh Revie, vice president regional sales (EMEA) at EmpowerMX. "This is the percentage of the mechanics' actual labour used that is paid for. The unpaid-for balance of the labour includes walking to and from task card collection points, tools and parts stores, leaving the job to speak to supervisors, and taking breaks. A lot of a mechanic's paid-for time is wasted because they have left the task in-hand and are in transit. Most of this wasted time can be eliminated if a mechanic is able to remain where they are performing a task, and can communicate with a supervisor and order parts through an electronic device."

Paper-based systems

The two main issues relating to labour efficiency in a traditional paper-based system are pre-check planning, and maintenance check execution. Both have inherent inefficiencies that result in relatively low labour efficiency and high overall maintenance costs.

The execution of a maintenance check involves performing a group of tasks either independently and simultaneously, or in a particular sequence because they are dependent on each other. Planning a complete check and arranging the tasks and allocating them to mechanics and technicians is actually difficult, and can only be done with any degree of accuracy for the initial stages of an airframe check when planned manually.

"The first issue is that while it will be known from experience how many mechanics are required to perform a task and the number of MH usually required for preparation and execution of routine inspections, there are several details that make it hard to estimate the exact elapsed time and MH used for each one," says Revie. "Elapsed time depends on factors such as: referring to relevant manuals and documents; gaining access; delays and waiting time due to supply of required tools, parts and materials; occurrence of findings; need to perform non-routine (NR) rectifications; and time to prepare these NR tasks. The overall difficulty of estimating the elapsed time of routine and NR tasks is what makes the manual check planning process inefficient.

"One of the most difficult things to predict at the start of a check is when each task will be completed, especially those performed further into the check," adds Revie. "Another difficulty in planning checks manually is that historical data relating to MH used and elapsed time, from a database of previous checks, is required to plan a check in detail. Whether it is done manually or electronically, the technique used for check planning is critical path analysis using a gantt chart. When done manually,

Manually planning and monitoring the progress of a check has several inherent inefficiencies. The first is that only tasks in the initial stages of the check can be planned, since it is hard to predict when they will be completed. Information used in planning a check as it progresses is often many hours or even several days old.

it will need to allow lots of margin, and so have spare time between tasks. The plan will inevitably have inefficiencies."

Mark Martin, director of operational edition product line, aviation and defence business unit at IFS, explains that in a traditional paper-based organisation supervisors have no access to real-time information, instead making decisions based on stale information because the processing of paper only starts when the task is closed and the paper is turned in to the engineering department. This does not reflect the current status of the job. Anything that causes a disruption to business as usual will exponentially affect efficiency. Eliminating paper and moving to electronic data and information makes the whole organisation more efficient.

A consequence of the lack of detailed historical data is that many maintenance facilities do not plan a complete check using a manual planning process. In most cases, it is only the first third or quarter of the check that is planned manually, and then the plan is progressively extended as tasks are completed.

The minimal planning approach followed in the traditional system often results in mechanics getting assigned task cards, and going to the tools and parts stores when required. Tasks will then be added as initial tasks are nearing completion, and it becomes clearer which mechanics will be free to perform them. This system is inherently inefficient.

The second half of a paper-based and manual system is performing routine tasks, and raising NR tasks as a result. This naturally creates inefficiencies.

"The first of these is the time spent by mechanics walking to and from their work position to get tools and equipment, getting materials, going to the parts stores to make requests and waiting for parts, and going to find supervisors and engineers to make consultations," says Chris Reed, managing director at Trax. "These activities use a lot of time, and take a mechanic away from the location of their maintenance task. Time is also lost when mechanics take breaks."

Barend van de Vrande, vice president of product management implementation and support at Aerosoft, comments that some maintenance facilities have a system of mechanics only being supplied a reference number applicable to their assigned task card. The mechanic then has to obtain a copy of the card by going to a computer terminal to print it off. Air Canada Jazz, for example, performed a time-and-motion study, which found that walk time to get cards varied from two to nine minutes, with an average of three or four minutes. A few more minutes were needed to print off the cards.

If it takes an average of three minutes for a mechanic to get a new task card, one MH can be saved for every 20 task cards with a fully electronic system. Across several tens of thousands of task cards performed each year, several thousand MH can be saved.

"Another inherent efficiency of a paper-based system is the time mechanics spend going through the various printed manuals, cross-referencing between manuals and searching for pages," continues Reed. "This will often result in mechanics switching to other activities, such as leaving the work station to go and find manuals, or request parts as a result of consulting a manual."

The difficulty that printed manuals present is that there are several of them, and a cross-reference to another manual will require several minutes.

Van de Vrande explains that reviewing tasks cards can be laborious, and has to be done every time under a manual and paper-based system. Printed task cards have to be reviewed to assess the tools, materials, and parts required, and to determine what access is necessary, and what mechanic skills are required. A further complication is that a standard task card written by an original equipment manufacturer (OEM) will not quote actual P/Ns, but instead will list reference numbers that have to be manually looked up to locate the various P/Ns that can be used. These will be listed in the IPC or APL. Their availability then has to be determined by searching manually through the standalone material inventory system. Care also has to be taken to ensure that each P/N that is known to be available is applicable to the aircraft and task card being worked on. This is another laborious and time-consuming process. An airline planning department should already know the applicability of parts to task cards, and task cards to particular aircraft L/Ns. A third-party maintenance provider will take about five minutes to check the applicability of P/Ns to a task card that has been provided by its airline customer.

Another issue is tools required and their availability. A problem with a manual system is that mechanics often find that requested tools and parts are not available in the store, so a task cannot be performed. This is avoidable with an electronic planning system.

A further complication with task cards is the applicability of a variant of a maintenance task card to the particular aircraft L/N or serial number (S/N) that is undergoing maintenance. A maintenance task will only apply to certain aircraft L/Ns or S/Ns. In addition, two or more versions of a maintenance task apply to an aircraft depending on whether they are pre- or post-modification, and which group of L/Ns it belongs to. Care and time are therefore needed to ensure the correct version of the task is used for the aircraft being worked on. This is another factor of relatively low labour efficiency in a manual system of planning and executing aircraft maintenance. Again, this can take about five minutes.

Further delay is caused by the time taken to leave a work position to go the

parts store, issue a request, wait for the part, and then return to the work position. Walk time can be about three minutes, but up to 15 minutes can be spent waiting for the part to be issued.

Routine tasks and inspections regularly result in findings and problems that generate the need to consult supervisors and managers. This inevitably results in transit and wasted time.

Consultation with supervisors and engineers is often the result of a finding that ultimately leads to the need for an NR task to be prepared and completed. "Preparation of an NR task can take several days," says van de Vrande. "A similar delay is experienced when a mechanic requires specialised mechanic skill, such as an avionics engineer or non-destructive testing (NDT) capability."

There is further labour inefficiency after a maintenance task is complete. The return of unused parts and tools to the stores further consumes mechanics' time, as does signing off paper task cards, and collecting the next assigned task.

Evolving process

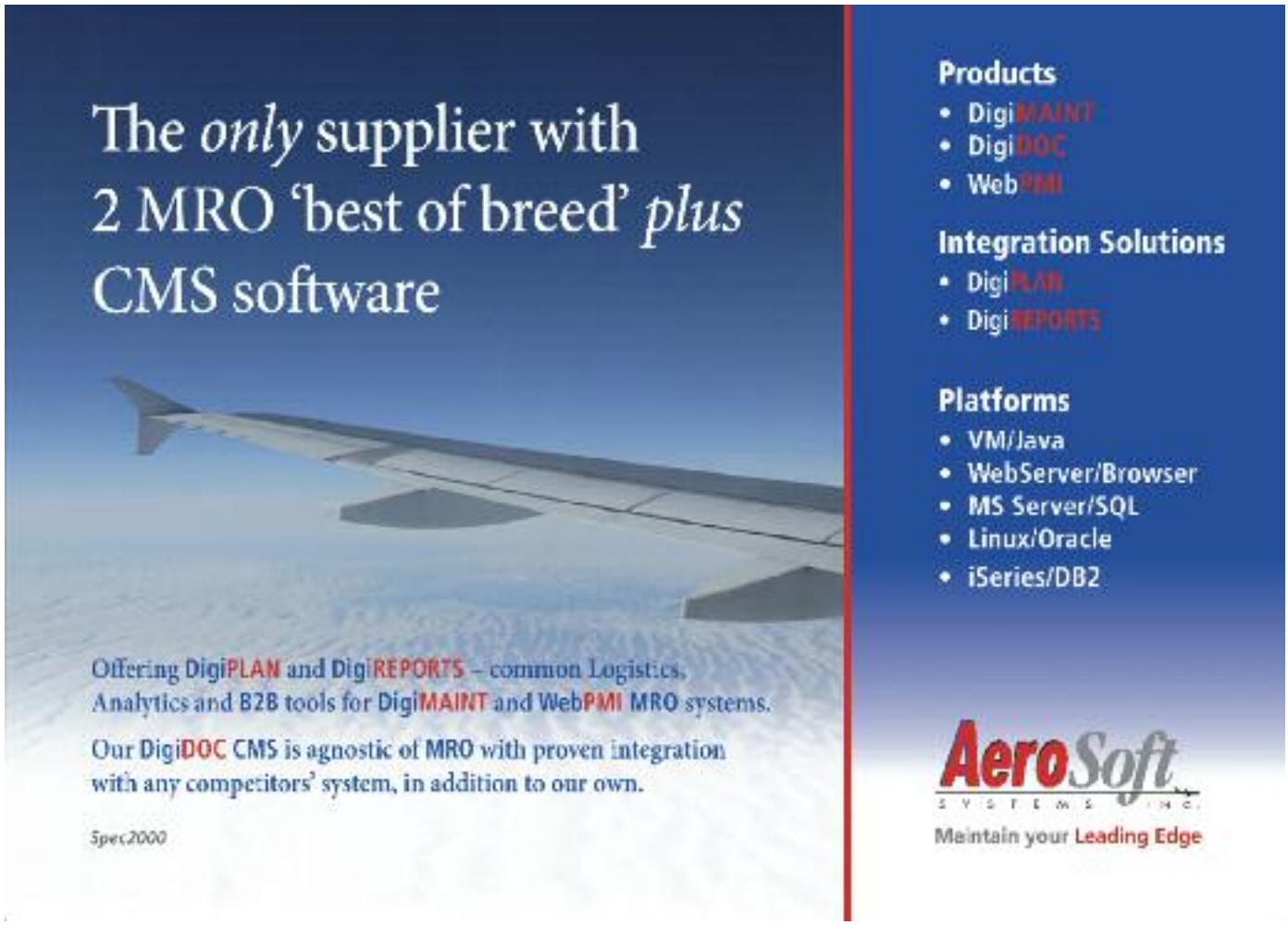
Significant gains in labour efficiency can be realised through performing the complete planning and maintenance execution process electronically. "The typical 45-55% levels of labour efficiency of a manual and paper-based system can rise to 80-85% once all stages and elements of planning and maintenance execution have been made electronic; and engineering and supervisory staff and mechanics have become used to working with the system," says Revie. "There are three stages to evolving from a pure paper-based and manual system, to a fully electronic one, but first the M&E systems and their functionalities have to be examined."

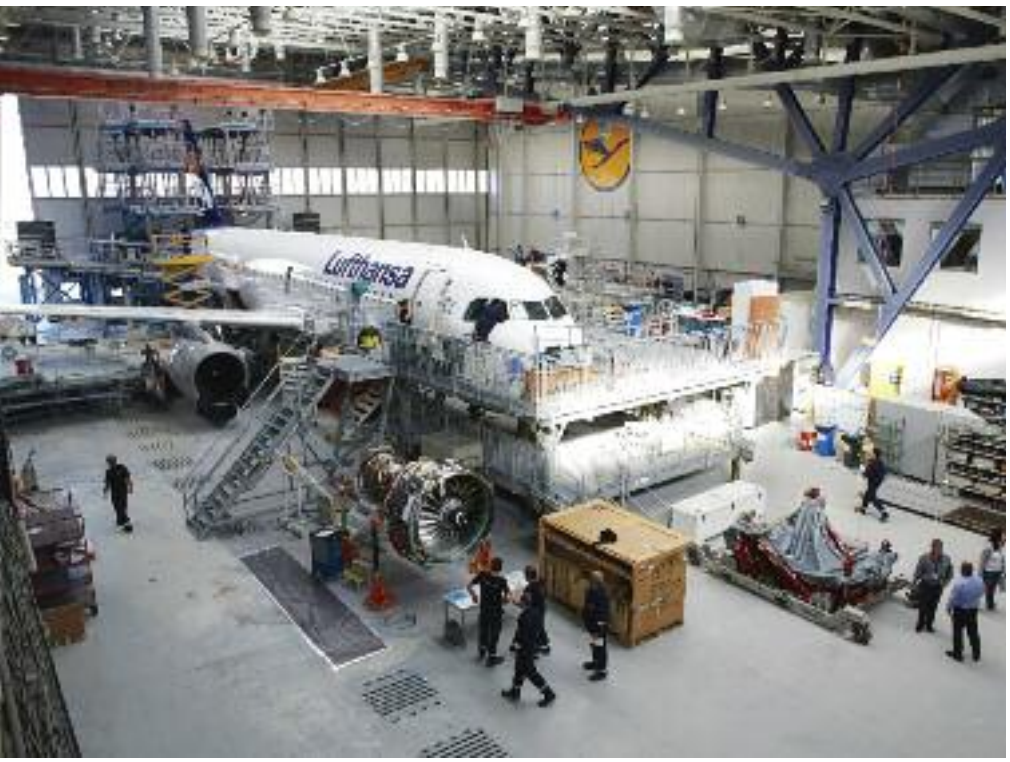
Many maintenance IT solutions were designed for use by airlines, and were initially developed for engineering management and continued airworthiness management organisation (CAMO) functions. "These systems have now added maintenance planning, maintenance execution, shop floor data collection (SFDC) capture and database storage, personnel management, and asset management and finance activities. These systems are not so preferred by independent maintenance providers," says Revie. "Other systems, such as our FleetCycle system, started primarily as a maintenance planning and execution system, and have had their capabilities expanded into all other areas from there. FleetCycle has been especially developed to constantly monitor the progress of a maintenance check in real time, and present the information visually so that the check plan can be constantly adjusted. The issue of maintenance execution is that labour accounts for most of the cost, so reductions in MH used will realise large savings."

The three stages of migrating to a purely electronic system are first changing the planning process to one performed electronically. This uses a critical path analysis system, which includes detailed historical data collected from the same checks performed earlier on the same aircraft type. "Changing to an electronic maintenance planning system is then followed by developing the system of non-routine tasks into an electronic process. The third stage is developing the routine tasks from a manual process to electronic," says Revie.

The basis of performing maintenance electronically is with the use of an interactive or integrated electronic task card. "Integrated task cards mean that all work and related documentation is delivered to the mechanic at their place of work, so they do not waste time fetching task cards and searching through manuals," says Reed. "Once the system is operational, then more accurate start and stop times are recorded for each task. Also, the work status of each task card can be monitored as each sub-task is completed, so management has visibility of check progress via dashboards. Tasks that are taking too long to complete, and so are overrunning, are easily identified.

"One particular benefit is that non-routine task cards can be raised very quickly or even immediately at the point of work. This is partly because the





Some steps can be taken with manually-planned checks to improve labour efficiency. These will be having all relevant tooling and parts in place on the day of the check that particular tasks are planned to be executed. Transferring to an electronic system of check planning is the first stage to convert to a fully electronic system.

electronic system means a lot of data and information can be autopopulated," continues Reed. "Other features include engineering report requests being made immediately, unscheduled materials being requested at the point of work, rotable exchanges being reported at the point of work, and measurements or data relating to findings being transmitted to the engineering department promptly. These features mean that the engineering team gets information to plan additional work very quickly, because many repairs are pre-configured."

Improved planning

The first and simplest step in improving maintenance planning is by having items such as gantry, access equipment, tooling, manuals and documentation, and known parts and materials in the right place at the right time. This can be organised each day by the supervisors that are aware of the progress of an airframe check, and which tasks are next to be performed.

One of the first steps in a task is gaining access to the right zone of the aircraft. "Using non-qualified or under-qualified mechanics, such as apprentices, to erect gantries, open access panels and clean areas to be maintained will not save labour MH, but the MH used for these elements of the maintenance task will be performed at a lower labour rate per MH," says van de Vrande.

Mechanics' time can be saved by having delivery clerks bring required manuals and parts to the mechanics. This is overall cheaper, since the mechanics, which are paid at a higher rate per hour, do not have to leave their workstations.

"Simple solutions include having all parts, tools and relevant items already available in a location close to the area of work on the aircraft placed on boxes, with labels printed with the associated task card number," says van de Vrande. "This simple level of organisation not only saves time, but if coordinated well in advance will avoid delays by ensuring that a tool is not being calibrated and is instead available when required."

Other small improvements can be made in the manual and paper-based planning by printing manuals and task cards in advance. Tasks can be bundled, and so several made ready for a mechanic to be performed in sequence.

Electronic planning

The first stage in electronic check planning is to have the elapsed time, and MH and part consumption data available from previous airframe checks. This comes from the use of SFDC data and information of the same checks performed on the same aircraft type. "The use of SFDC does not make the process of maintenance execution any more efficient, as mechanics still waste time and lose efficiency in walk time," says Reed. "While SFDC makes no difference to the efficiency of performing a task, it allows accurate data to be collected for future use."

The accurate data collected by SFDC can be archived and then used to plan future checks, using the critical path analysis technique in an electronic check planning system. "The accurate data can primarily be used to produce a more accurate elapsed time for the check," says Reed. "The plan for a certain check in the maintenance cycle of a particular aircraft type can then be constantly refined. This is especially the case with important issues such as MH for access and the incidence and size of NR tasks. There is also more accuracy in estimating sub-tasks. A side benefit of SFDC is that an MRO gets accurate MH data to use in billing, and more accurate information for its own internal purposes to improve its cost of mechanic labour per MH". In some cases, MROs have found that they are able to increase billable MH by 10%, mainly because mechanics record time taken to perform tasks inaccurately.

"Systems such as OASES can have an impact on labour efficiency in organisations using traditional paper systems," says Julian Beames, business operations manager at Commsoft. "This is because the system holds a vast knowledge relating to the history of the activities related to maintenance tasks. All the data relevant to a task is held. This includes estimates of labour MH used, inspection sign-off requirements, parts used to routinely perform the task, and tools required. Relevant items can be prepared prior to a check, and parts ordered if required using stock control capability, and arrangements made so that all items are ready and available, including printing the correct workcard applicable to the aircraft."

SFDC information is not just used from previous checks to help plan future airframe checks. "Barcodes systems on printed cards for collecting SFDC is an out-of-date system," says John Stone, vice president of product management at Ultramain. Our mobile solution can generate efficiencies by collecting real-time data, and so create instant awareness in the progress of tasks and the check. It also reduces overheads related to dealing with things like tally sheets and generating bar codes for task cards.

"Having a system the correlates non-routine defects with routine task cards, identifying the reasons for worl stoppages and other maintenance production issues is also important," says Stone. "We are living in a world where data is king, and a system that collects data and provides meaningful insights into how you are performing will add to gains in efficiency."

Planning also involves organising the correct sub-tasks, tools, materials and parts so that they are available when the

A big factor of inherently moderate labour efficiency in paper-based maintenance execution is the time spent by mechanics consulting manuals and documents, leaving the work station to request tools or parts, and consulting with supervisors.

task is due to start. "This can be done with all relevant data available in the M&E and CMS systems," says van de Vrande. "Moreover, whereas it has to be done every time a check is planned in a manual system, it only has to be done once in an electronic system. This can save the mechanic, for example, 30 minutes each time the task has to be executed. This task may have to be performed several times a year on the same aircraft, so the savings for an entire fleet are appreciable. Then when the saving is considered across a percentage of all the maintenance tasks that have to be performed annually, then clearly hundreds or even thousands of mechanics' MH can be per saved per year thanks to efficient electronic planning."

The issue of sub-contracted maintenance to a third-party facility has to be considered. An airline will schedule the cards that have to be performed, and send them to the maintenance provider, which then plans the check. For example, project engineers at TechOps Mexico schedule which tasks have to be performed over the next 24, 48 and 72 hours, and revise the plan every 24 hours. TechOps Mexico receives task cards in PDF format from most of its customers. It uses the EmpowerMX FleetCycle system, and routine task card headers are loaded into the system for planning and tracking purposes. Tech Ops Mexico does not yet have an electronic data interchange between its customers' IT systems and its FleetCycle system, but it does electronically plan maintenance checks.

The overall benefit of switching to an electronic system of check planning is that the accurate assessment of MH and elapsed times to complete each sub-task and task makes it is easier to plan a tight sequence of tasks. This is without running the risk of the plan going wrong as a consequence of underestimating the elapsed time and MH used to complete tasks. This is particularly the case with dependent and sequential tasks.

"Knowing how many MH are being allocated to each shift through a resource planning system, such as OASES, and then knowing how many MH are eventually booked directly to billable work, an organisation can then start to analyse where there are efficiencies to be gained," says Beames. "These non-billable MH can be attributed to waiting time or other non-productive work in the SFDC system. This helps the organisation reduce these through targeted improvement schemes."

Revie comments that changing from a fully paper and manual system to electronic planning will improve typical labour efficiency from 45-50% up to 60%. "There are further benefits of first changing to an electronic NR system and then to an electronic routine system that can take labour efficiency up to 80-85%," comments Revie.

Non-routine tasks

With the planning process developed into an electronic system, the next stage for progressing the entire system into an electronic one concerns NR cards. Revie advises that this comes before turning the routine maintenance inspections from a paper-based system into an electronic process.

"The manual process of raising and creating NR cards is for the mechanic to first have a finding or fault when making the routine inspection," says Revie.

"From this point, the mechanic records the finding by manually writing down the details. These can then be passed to a clerk, who manually keys the information into the M&E system on a computer terminal located in a back office in the aircraft hangar. These are then printed off for the engineers in the maintenance and check planning department.

"The NR card is then written by engineers in this department, and there will be several standard NR cards that are pre-written for each task," continues Revie. "In some cases of exceptional or unique findings, NR cards will have to be written for the first time. This may require further detailed inspections by supervisors and engineers. The completed NR card is then sent to the hangar floor. The writing of the NR card requires a lot of information from several sources, including manuals, and in some cases design work by the maintenance provider or from the original equipment manufacturer (OEM)."

The NR creation process is developed into an electronic system by giving mechanics an electronic device for use in conjunction with paper routine task cards. This is therefore the first time an electronic device would be introduced into the maintenance production process. "The mechanic will record the findings and other information for an NR on the device," explains Revie. "The device will have a series of standard NR reports for each routine task card, and the mechanic can select the appropriate one. These standard NRs will be sufficient in most cases, but the mechanic may have to record something new if the findings are unique and have never occurred before. The NR report can then be sent electronically to the M&E system, rather than the findings having to be manually keyed into the M&E system."

This new set of findings can then be added to the list of standard NRs for future checks. Once the standard NRs for each routine task have been established, raised and recorded, a paper NR task card can be printed for the mechanic.

An electronic NR process can have several other features to enhance the functionality for a mechanic. All of these save time. The first of these is that the initial findings and write-up report associated with the routine card ensure that the routine card and work order numbers are linked to the NR card. This

automatically generates the header data and the reported findings are populated on the NR card. The routine card's work order number will have to be pre-populated if the user only has an electronic NR card system and the routine cards are still paper.

This template is then sent to the NR queue in the maintenance production module of the M&E system. The supervisors or engineers complete the NR card, depending on the severity of the findings.

Once the NR card is generated, several other features and functionalities are required. The NR card generated in the M&E system has signature boxes for electronic and digital signature added. All the steps and sub-tasks required to complete the NR task are listed on the card.

A system for routing and sending parts and components to the mechanic is also required to maximise potential savings in labour MH. The mechanic receives the correct parts and materials for the NR card.

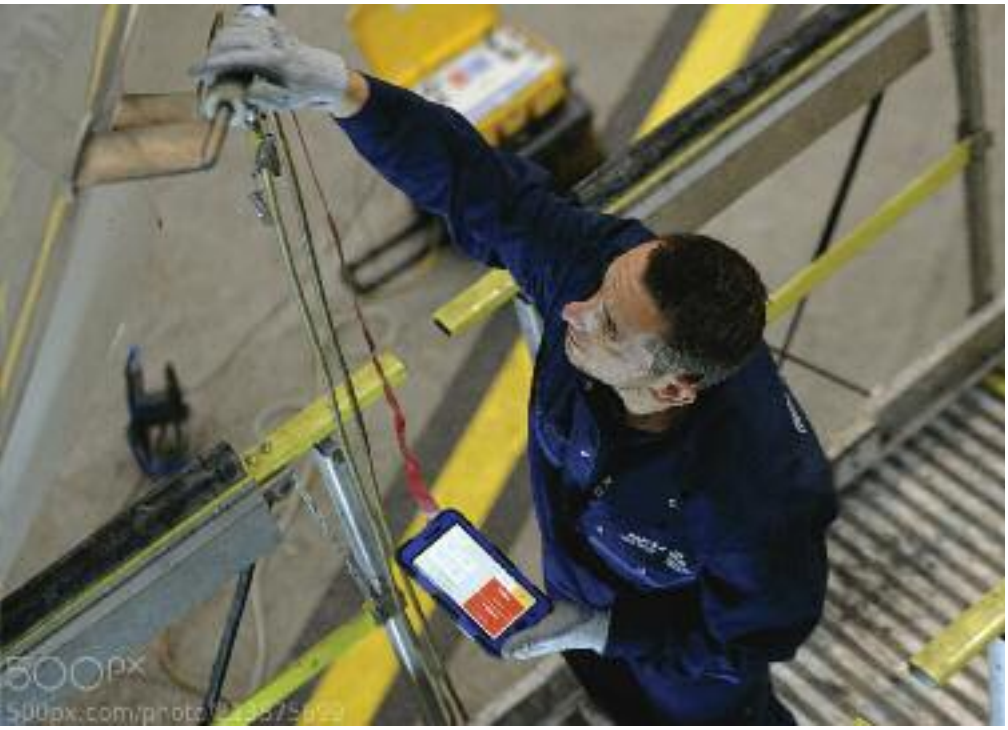
An example of the benefits of switching to an electronic NR system is Tech Ops Mexico, which used to take up to two days to raise and write NR cards. "This length of time was required because the NR card has to be reviewed once it has been written," explains Revie. "We got this down to about 15 minutes. This improvement is because the backlog that the planning engineer has to deal with is virtually eliminated with an electronic system. The labour efficiency has reached about 65% by the time the NR stage is fully electronic and all engineering staff and mechanics have become accustomed with the system."

Another example of the use of an electronic system for N-R tasks is Embraer Aircraft Maintenance Services in Nashville, Tennessee. It has 12 hangar bays for performing base checks and other maintenance, such as lease returns and interior refurbishment, for ERJ and E-Jet aircraft. In 2017 it performed 365 base checks and modification workscopes on these types.

The Embraer facility at Nashville implemented EmpowerMX's FleetCycle system in 2015, and has since used it to perform NR task cards electronically on all 12 lines. The company is a third-party MRO provider, so its airline customers plan the checks on the aircraft and send the work packs of task cards to Embraer. These are traditional paper task cards. "We use what we call an electronic cover sheet with the paper routine cards," says Phil Bathurst, managing director at Embraer Aircraft Maintenance Services. "We use these to monitor the progress of the routine cards, so start and finish times and other details such as MH and parts used are recorded on this cover sheet. The information is sent to FleetCycle, and it allows us to follow the progress of the routine tasks through the check. The mechanics take the instructions and all related sub-task steps from the pages of the associated printed task cards.

"The main issue for us has been using the FleetCycle system for performing NR task cards," continues Bathurst. "Because of electronic cover sheets for the routine tasks, and the electronic NR task cards, we have complete visibility of all the tasks as the check progresses. It means we know what should be completed each day. The system has allowed us to realise the largest possible gains in labour efficiency with respect to NR task cards.

"The net result is that the fully electronic and interactive task card, viewed mainly on tablets but also computer terminals, has reduced the time to prepare NR task cards from 12 hours to less than one hour," continues Bathurst. "One example of a time-saving feature is that elements of the routine task card, such as headers and job number, and autopopulated on the NR card, so the time to perform many elements of generating NR cards has been shortened. The only issue that holds up generating NR cards is the primary inspection. Once this has been done then NRs can be



With mobile maintenance or interactive task cards on electronic devices, it is possible to improve mechanics' labour efficiency from the typical levels of 45-50% with a paper-based system, up to at least 70%, and even as high as 85% in some case, with a fully electronic system.

produced very quickly using the system."

Bathurst explains the overall effect of improving the efficiency in generating interactive electronic NR task cards has been for a significant rise in labour efficiency, and so the effective value of labour charged increased by 20%.

Another example of a maintenance provider that operates an electronic NR card system is TechOps Mexico. This was implemented in May 2016 with the FleetCycle system. The mechanics use computer terminals located near the aircraft. The electronic NR system has reduced the buyback time from one shift to 10 minutes. That is, inspection times following task completion has been reduced.

The overall result of using an electronic planning and NR task card system is that TechOps Mexico inducted an additional maintenance line without adding any mechanics. It estimates this is the equivalent of saving total direct maintenance expenditure by 6%.

Routine tasks

Developing an electronic system for performing routine task cards is the third and final stage of migrating maintenance planning and check execution from a manual to an electronic process.

To gain full benefits from an electronic maintenance production system, an interactive task card system has to be developed. To be interactive the task card must not only be displayed on the device's screen, but must have features that prevent a mechanic needing to perform the traditional manual steps associated with a paper task card. Many interactive task cards are created as an HTML card. These cards are generated by downloading data from the M&E and CMS systems. The system therefore requires connectivity between the M&E system and the mechanics' devices.

A fully interactive task card will therefore first present the relevant pages of the task card on the mechanic's device. This will clearly save time spent leaving a work position and walking to pick up a new printed task card. When configured with an M&E system and a CMS, time can also be saved by ensuring that the right task card is presented for the aircraft L/N or S/N being worked on.

The mechanic can request a new task card after completing the previous task card, without having to move.

The first feature an electronic and interactive task card will have is the ability to record various findings. In addition to those relating to the generation of NR cards, many routine task cards also require measurements and calibrations to be taken and recorded. The task card will therefore need fields for the mechanic to key in these measurements. The system will therefore require connectivity to send these recordings to the M&E database.

The electronic and interactive task card will require links with the relevant document and manual pages that the mechanic will need to consult while performing the maintenance task. This will save time that a mechanic spends searching for and consulting manuals in a traditional paper-based system.

Two systems can be used to make relevant manual pages available to the mechanic. One is for the M&E and CMS to be configured so that the manual and document pages relevant to the task card are included as a section of the task card. A usual system to provide these pages is for them to be created on screen from manual and document data held on the M&E or CMS that is written in extensible mark-up language (XML). Another system is for there to be links between the routine task card and the relevant manual pages.

A second main feature of an electronic routine card system will be the ability to request parts and materials via a mechanic's electronic device. The P/Ns listed on the associated manuals and documents pages are listed in the IPC and APL. Links from the task card and manual pages allow mechanics to send requests for them to the parts store.

A further level of capability will be parts and inventory management functionality that will record the number of each P/N held in stores and consumed in checks, and all associated ordering and accounting processes.

Some M&E systems have developed a shopping cart style system for mechanics to request parts while working in situ, and going through all the steps and sub-tasks. Requested items can then be delivered to the mechanic by a clerk to realise the maximum possible savings in the mechanic's time and thereby improve their working efficiency. A less efficient system would be for the system to send the mechanic a message to tell them their parts are ready for collection at the parts store. This requires some downtime for the mechanic, but saves the labour cost of a delivery clerk in the hangar.

This means the mechanic's device would need to be wirelessly connected to the M&E system in real time.

A similar capability to this is the recording of rotable and repairable component changes. Components with fixed or hard-time intervals have to be changed for some tasks, and other system tasks reveal faults or failures that result in components having to be removed and replaced. These changes have to be recorded, and details of the removed and installed items keyed in on the relevant boxes of the interactive task card.

In conjunction with this, data relating to the component change has to be recorded in the M&E system. The first will be the change in the aircraft's configuration. A further enhancement will be a rotable and repairable component tracking and monitoring system. This will collect on-wing and removal interval data, and estimate the

inventory of rotables required.

Another feature of an interactive task card is the ability to communicate electronically with supervisors and managers, which can be done without the mechanic needing to leave the position on the aircraft where they are working. Mechanics can even take pictures of findings, and send them by email to the supervisors and engineering offices.

Interactive routine task cards are more likely to realise a benefit for airline-operated maintenance facilities, because airlines will plan checks and write interactive routine task cards on their M&E systems from XML data. This will be used directly on mechanics' devices to form task card pages. For an independent MRO to have an interactive routine card generated for an airline customer, the airline's M&E system will have to be interfaced with the MRO's system, and data transferred in XML format. "With the IT systems currently being used, the transfer of XML data back and forth between airline and MRO systems requires a lot of formatting and re-formatting," says Bathurst. "This incurs additional cost, and some airlines do not see this as beneficial compared the labour saved. This is particularly because more airlines are seeking fixed-cost contracts for airframe maintenance, and labour efficiency is therefore just an issue for the MRO. An MRO could, however, potentially offer more competitive fixed cost rates to airlines with improved labour efficiency for routine task cards. In the long term, it may prove to be beneficial for MROs to use interactive routine task cards in the future if there is a common XML schema that allows data to be transferred seamlessly between all M&E systems. This would eliminate the need to format and re-format task card data between airline and MRO M&E systems, saving the cost and leaving only the benefit of fewer MH consumed."

Overall benefits

Revie comments that targeting labour efficiency of 80-85% is a possibility, and achieving this would be regarded as a good result. "It is possible to get up to a labour efficiency of 70% or better when the planning, non-routine and route card preparation and execution is electronic,"says Revie.

Another element in developing the process into a fully electronic system is through implementation of a dashboard. This essentially shows the progress of the check plan on screen, and is constantly updated in real time as non-routine tasks are raised, routine and non-routine tasks progress and are completed,and various delays encountered or milestones achieved. A dashboard will also produce a constant tally of MH and materials consumed, and regularly update the predicted completion date.

"This is only possible, however, if the M&E system being used can have relationships between tasks and parts, planned and actual MH, aircraft L/N and task card, aircraft L/N and P/N, and many other factors," says Stone. "This information is used in advance of a maintenance check to ensure there are no surprises. Overall, the important issue is keeping the mechanic on the aircraft, and this can only be achieved through a paperless process and mobile devices."

Further follow-on benefits on an electronic system are the time and cost saved by not printing and checking all completed printed task cards by engineering staff. Moreover, there are fewer errors that have to be audited. A breakdown of inputs used is generated, which is useful for monitoring aircraft maintenance costs and generating invoices for third party customers. It is also possible to have a system where the efficiency of different hangars is compared. - *CHW* AC

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