

Irish company CloudCARDS has developed the CARDS application to manage the transition of aircraft between operators via aircraft lessors. The system analyses an aircraft's maintenance status, and generates a maintenance workscope to enable smooth transition to a new operator.

CloudCARDS system for managing aircraft transitions

While there are a large number of maintenance and engineering (M&E) IT systems to manage aircraft and fleet maintenance, airlines often still experience large problems with aircraft asset management in lease contracts. CloudCARDS Ltd. of Shannon, Ireland provides an application called Civil Aircraft Remote Delivery System (CARDS®) with the functionality to perform asset management tasks.

CARDS operates with several main levels of functionality, including: management of document and technical document, or maintenance records; viewing and reviewing maintenance records; aircraft physical inspection via a tablet device application; asset management of aircraft during the lease term, and management of transitioning aircraft between operators.

"Airlines need these functionalities when managing aircraft within an operating lease," explains Brian Fitzgerald, managing director at CloudCARDS Ltd. "Our CARDS® software is mainly used to minimise the many and expensive complications that arise when an aircraft transitions between operators. These can cost a lessee, owner or new operator hundreds of thousands of dollars. It's important to appreciate what problems often arise between airlines and lessors or other operators at lease end and aircraft sale."

Aircraft transactions

Bad experience with aircraft transactions in the past has led lessors and new owners to stipulate that an aircraft, its engines and components must be in a certain state of maintenance, and have a certain configuration, at the time of aircraft handover. Taking an aircraft

without doing proper due diligence prior to delivery has led to owners and new operators walking into unexpected and large expenditure, for a variety of reasons, including: reconfiguring the aircraft interior; performing airworthiness directives (ADs) and service bulletins (SBs) that should have already been done; changing the aircraft's component and avionics configuration to the desired state; and dealing with outstanding major maintenance items.

Aircraft maintenance status is complicated, however, by the fact that in addition to a large number of scheduled airframe maintenance tasks, some engine maintenance is performed on an 'on-condition' basis. It is relatively easy to specify that a certain group of airframe tasks, with specific intervals, should be performed so that the aircraft is clear to operate without them coming due within a specified period after the start of operation. Because engines are maintained on an on-condition basis, however, they can come due for maintenance at an unpredictable time, although intervals for on-condition maintenance are easy to predict.

About 40% of aircraft are acquired through operating leases. Many airlines take advantage of the flexibility that operating leasing provides, particularly the relative ease of changing fleet structure and keeping average age below a certain number of years. One major pitfall is that lease terms expire at times that are out-of-phase (OOP) with major airframe and engine maintenance events.

Operating lessors' standard practice is to stipulate that aircraft are returned in a specific maintenance condition at the time of lease expiry. Peter Cooper, planning manager at Civil Aviation Services, Shannon, Ireland says that a typical condition is that aircraft are free of all

major airframe maintenance events for a period equal to a C check. "An example is an operating period equal to two years, 7,500 flight hours (FH), and 5,000 flight cycles (FC) for an A320," says Cooper. "This is because the A320's maintenance planning document (MPD) stipulated these three interval criteria as the aircraft's basic C check interval in earlier MPD revisions. While the later MPD revisions do not specify an actual C check, a large number of tasks that were grouped into the original C check now have one or two of these intervals."

There are of course a large number of airframe tasks with shorter intervals, and these will normally be performed during line and A checks. "A lessor or new operator will expect to have to perform these tasks once or several times before a C check comes due," says Cooper. "What a lessor and a new operator will require, however, is that no tasks, in the example of the A320, with intervals equal to or longer than two years, 7,500FH and 5,000FC, will come due between taking delivery and the first C or base check. This means these tasks have to be carried out before delivery to the new operator."

A similar set of stipulations will be made for major maintenance coming due on major components, such as landing gear and the auxiliary power unit (APU), as well as on-condition maintenance hardware in the engines, and life-limited parts (LLPs) in the engines.

To avoid complications and the need to perform additional and expensive maintenance during an aircraft transaction, the existing operator must perform a large workscope of maintenance before ceasing operations with the aircraft. This is intended to put the aircraft in a maintenance condition that meets all the lessor's or new operator's needs.



The CARDS application will generate a gantt chart of maintenance events coming on the aircraft in the final months as it approaches transition to a new operator.

Complications

The complications that arise during aircraft transitions and transactions stem from an operator's inability to meet all end-of-lease or aircraft sale maintenance condition and aircraft configuration requirements. The first of these is that, although there are several main task interval groups, a large number of MPD airframe tasks have their own intervals, and may be regarded as out-of-phase (OOP) tasks. While it is easy to keep track of a large number of tasks, that are referred to as a certain base check and number, there are several hundred OOP tasks on each aircraft type's MPD. This makes it easy to miss or forget to perform tasks prior to ceasing operation.

There are also a large number of main MPD tasks with high intervals that may have been missed. Another reason for missing a maintenance task is that some structural tasks have repeat intervals that differ from initial threshold intervals, and so can be overlooked. There is also the applicability of specific tasks to certain line numbers, to aircraft that have had certain ADs or SBs performed, and to certain or specific weight variants.

Another issue is whether ADs and SBs have been performed on the aircraft. Some optional ones may still be required by the new operator or lessor/owner. Other ADs or SBs may not have come due during the original operator's period of operation, but are due within a few months and so have to be completed. Moreover, some ADs may not be required by the original operator's regulatory authority, but are mandatory for the new operator, or desirable for the lessor and which help in re-marketing the aircraft.

ADs and SBs can be complex to

interpret. "There can be hundreds of them to analyse for an individual aircraft. The applicability to one aircraft is time-consuming and complex," says Fitzgerald. Moreover, an airline's engineering team's main function is to keep its operational fleet airworthy, so it will not be focused on analysing ADs and SBs for an individual aircraft with respect to returning it to its lessor or preparing it for its new operator.

"There can be a number of ADs and SBs to perform, including those that come due during the first period of operation with a new operator that is equal to the base check interval," Fitzgerald adds.

Another element of maintenance that generates difficulties is an aircraft's rotatable component maintenance status and configuration. Some components are life-limited. Lessors and new operators may require an aircraft to have life-limited rotatables with remaining lives that are at least equal to the main base check interval, again to keep the aircraft clear of major hangar base maintenance for a period equal to the first base check. A need to change expired life-limited components early will result in aircraft downtime and extensive maintenance.

Another problem is that an operator may have used rotatable components from a specific supplier, but a lessor or new operator may require different ones to be fitted, forcing the need for hangar downtime to change the components. Moreover, specific component serial numbers (S/Ns) may only be used in certain positions on the aircraft depending on whether an AD or SB has been performed. Different part numbers and S/Ns may need to be installed if the aircraft's AD and SB status changes.

In addition, the aircraft's interior will

need to be changed. "This can represent a large package of work, and will require the writing and creation of an engineering order (EO), which takes a lot of time and preparation," says Fitzgerald.

The problem that most airlines have when preparing aircraft for handing back to a new lessor or selling to a new operator lies with how their engineering departments work. These use M&E systems primarily to maintain regulatory compliance in terms of aircraft maintenance status. They then plan maintenance events and tasks in relation to actual aircraft FH and FC performed, and predicted future FH and FC due. Engineering departments also focus on additional management tasks to decide which ADs and SBs to perform and when to incorporate them, and when to arrange a number of other maintenance tasks.

Engineering departments often do not have resources or software applications to prepare aircraft for end of service and transition. As their mandate is to keep the operation running cost-effectively, the lease return and its legal requirements as per the lease are often ignored or unknown until it is too late to react. The delays, additional rent, hangar time and engineering resources can amount to hundreds of thousands, and sometimes millions, of US dollars per aircraft.

Transition management

The conventional way of preparing an aircraft for transition starts about a year before the end of operation. "This needs due diligence because complications will inevitably arise if proper preparations are not made," says Fitzgerald. "These complications will almost certainly end up being very expensive to overcome. An airline lessee will lose its deposit held by the lessor if the aircraft is not ready for the re-delivery on the date specified in the condition specified in the lease."

Proper due diligence will reveal the extent of work that has to be done, but Fitzgerald warns that there is rarely enough time to examine the aircraft's maintenance status and analyse it in terms of preparing it for transition.

The first stage of a conventional preparation for transition is to perform a pre-delivery inspection 12 months in advance. "There should also be a meeting at this stage with all the relevant parties, including the current operator, the owner,

One functionality of CloudCARDS's system is to take information from a physical aircraft inspection performed remotely. The information gained by a tablet computer is then analysed together with scans of maintenance records. From this the aircraft's maintenance status is determined. This is the first stage of preparing an aircraft for transition.

lessor, and the next operator. It may also include inspectors and a maintenance facility," says Fitzgerald. "Agreement is reached on the aircraft's required maintenance condition and status at the time of transition, including: what customisations have to be made, for example to the aircraft's interior, and its rotatable component configuration; and the new maintenance programme that the aircraft is going to be operated on."

A physical inspection of the aircraft is carried out at the 12-month point. "This is an interior inspection for condition and external inspection. It is referred to as a structural dent and buckle inspection," says Fitzgerald. "The aircraft will be physically examined for all external repairs made and due to be made, and then these will be cross-referenced to the maintenance records for each repair. These maintenance records are inspected to check if the repairs have been carried out properly and are in full compliance."

Also examined at this stage will be the aircraft's technical log, in particular to search for outstanding technical faults.

"Following this process the current operator should write an EO of all the issues found, source and order the parts needed, especially the interior parts, then prepare a draft workscope for the maintenance tasks and modifications that need to be done to the aircraft before delivery," says Fitzgerald. "At six months before transition the current operator starts to build a delivery book (DB) for the aircraft. This collates all relevant maintenance and technical documents for the aircraft. These will either be signed hard copies ('dirty fingerprint' copies), or electronic scans of the records.

"This process can take a long time if the airline's engineering department has not prepared for the re-delivery, because they have to audit the records and populate the DB with the relevant technical records," continues Fitzgerald. The DB is an index of the aircraft records required to transition the aircraft. The DB index can be stipulated in the lease or sale agreement, or it can be the operator's own index. If it is accepted by the lessor it is the basis for the records building.

The aviation industry is now moving towards an international standard for the DB. "CloudCARDS has been active in promoting a standard that is in use with CARDS," says Fitzgerald. "Of course the



industry will not change overnight, but the benefits are clear for our customers."

At four and a half months to transition the current operator gets feedback from the lessor about how satisfied they are with the aircraft's DB, and the quality of the records being presented. This feedback is important to ensure the process is on track and expectations are being met. The aircraft's maintenance status is constantly changing, so several records provided will be in draft format. The draft is still important, since regulatory or airworthiness authorities require different layouts and reference data to be shown.

The aircraft's maintenance status is constantly changing because it continues to operate even as maintenance is carried out on it to prepare it for transition.

"At three to four months to transition a workscope of maintenance that needs to be done for the aircraft to meet re-delivery conditions is formed and circulated to all parties," says Fitzgerald. "This is often a very large workscope, and it is scrutinised by the lessor and the new operator's technical department which can request changes to the workscope. There are also findings when the maintenance records are reviewed again. Other issues that can occur are other ADs and SBs being issued in the meantime. It is even possible that some maintenance has to be performed all over again if the records cannot be verified. This can happen if something as simple as the certificate of return to service (CRS) is lost. This can delay the transition by one or two months, which adds to the cost."

The final maintenance workscope will then be performed after ceasing operations with the current operator, and just prior to delivery to the new operator.

CARDS software

The transition process and its complexities provide the user with functionality to examine an aircraft's maintenance status, and from that point carry out all the work electronically. "The first stage that can be simplified is the initial physical interior and external inspection, because CARDS allows the physical inspection to be made via a tablet computer," says Cooper. "Only the inspector has to be physically at the aircraft. The inspection and electronic scans of the aircraft's maintenance records can be uploaded to CARDS by the operator for inspection by the lessor remotely. Once approved by the lessor, the next operator can inspect and approve the records remotely."

The users of CARDS are the current operator, the owner/lessor, the next operator, the MRO and the CAMO. Any third party can be added with certain access rights to ensure they can only view data relevant to their role and contract in the aircraft's management.

The aircraft's current operator then collates the technical records in relation to the aircraft's approved maintenance programme (AMP), and the maintenance status is determined. The system therefore has to be fed with all the operational data relating to FH, FC, and defects, and the maintenance data relating to maintenance tasks performed and components changed. These data are fed into CARDS on a weekly or monthly basis by dragging and dropping on a computer or tablet.

There are two ways of entering operation and technical fault data: to manually key in the information; or to interface CARDS with airline systems.

"CARDS saves a lot of money at the



start, since a full team from the lessor is not required to inspect the aircraft on site. They can go through the technical records on-line, audit them, report any issues found to the operator within the software platform, and allow the airline a structured process by which they can close out the issues. CARDS can also be programmed with the operator's maintenance programme, as well as the lessor's return conditions. The whole process can be done remotely, although the return conditions must be interpreted by a member of staff," continues Cooper.

Fitzgerald explains that CARDS uses scans of the dirty fingerprint technical records. "Airlines are moving from the traditional system of paper technical records. The first stage is to use electronic scans, and the second is to digitise all maintenance records," says Fitzgerald. EASA is changing its part M regulations, and has instigated a policy that from the second quarter of 2017 airlines can use electronic technical records as an alternative to paper and physically signed technical records.

"CARDS allows the user to drag and drop scans of paper technical records, and the system can be used to analyse the aircraft's maintenance status from this point," says Fitzgerald. "CARDS can be used to identify all the work that needs to be done to meet the lessor's and new operator's delivery requirements. One attraction of CARDS is that it structures the project management. During a lease return process, which involves many different parties, expensive delays can be caused by mistakes, miscommunications or lack of communication. Another reason for using CARDS to put together a structured project management approach is that EASA and the FAA are

changing the regulations that clearly outline the operator's responsibilities to ensure proper communication and oversight during complex maintenance activities, such as lease returns. This is a direct consequence of incidents occurring during lease return demonstration flights, that can be linked to breakdowns in clear communication and process."

Once the aircraft's maintenance status has been determined, CARDS can be used to automate the transition process. It provides visibility into the aircraft's technical records, its maintenance status, its AD and EO status, and its interior and rotatable component configuration.

Once the aircraft's full status has been established, CARDS generates a gantt chart of all major maintenance tasks and other events coming due up to transition. These are all the maintenance events that have to be performed to keep the aircraft airworthy for the current operator, and to get it into the correct maintenance status.

The main tasks will be required maintenance, all required ADs and SBs, component changes, heavy maintenance tasks, and interior reconfiguration.

CARDS allows the tracking of all the relevant information during this period, and shows the aircraft records acceptance status that is in the DB.

"CARDS follows the asset during the period leading to the transition date," adds Fitzgerald. "It does not delete any technical records, and also follows all the relevant rules and regulations."

Asset management

While CARDS has the resource and software ability to manage an aircraft asset and analyse and illustrate what maintenance has to be done before

An analysis of an aircraft's maintenance status and final maintenance workscope is determined by CARDS prior to transferring the aircraft to a new operator. The system is designed to eliminate omitted maintenance tasks, which would otherwise incur large costs for the previous operator.

transition, it does not have the same level of functionality as a full M&E system. So CARDS does not keep a complete record of the aircraft's component configuration, manage the aircraft's maintenance programme, receive feeds of FH and FC, and pilots' technical logs from an airline's flight operations department, make a complete plan of an extensive airframe check, maintain all records and information relating to personnel, and track rotatable components.

"Airlines tend to receive better order and purchase price discounts than lessors when ordering aircraft," says Fitzgerald. "This is certainly the case with large airlines placing bulk orders. Airlines are not often, however, able to finance all the aircraft themselves, so they often do sale-and-leaseback transactions with the lessors after placing the orders. Airlines have to conform to lessors' requirements at the end of lease terms, but their technical departments are usually not geared to performing asset management functions to meet these requirements.

There are many financial pitfalls for an airline. "An airline can save up to \$250,000 per aircraft when using CARDS by avoiding most or all of these pitfalls. Savings come from accurately assessing the aircraft's maintenance status, determining the correct maintenance required, avoiding the lessor's penalties and not losing deposits they hold, all because CARDS prompts the airline to do what is needed well in advance. It also reduces to a minimum the number of engineers needed to carry out inspections, collate the maintenance records and identify maintenance events."

So far CloudCARDS Ltd has attracted more than 50 customers and over 200 users. These include regulatory authorities, airlines, lessors and aircraft owners, aircraft manufacturers, technical services and engineering management providers, asset management companies, and independent maintenance providers. "Lessors, for example, use the system to review the aircraft when performing deliveries, redeliveries, and annual inspections," explains Fitzgerald. "Our customers include some high-profile flag carriers that use the system to prepare aircraft for sale or return to a lessor." **AC**

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