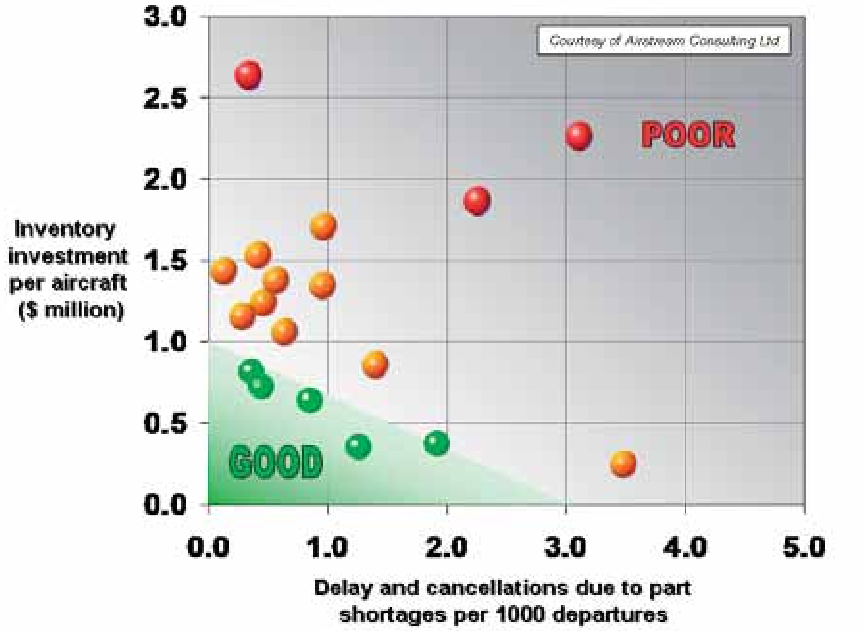
Excessive costs of holding surplus inventory has been a constant problem and challenge for airlines. Systems are now available that allow airlines to make reductions in inventory spending and sell surplus stock.

Systems to monitor inventory & rotables

The management of aircraft spares and consumables within an airline or maintenance and repair (MRO) facility includes several key areas: demand management, modelling and forecasting; material management, in terms of order fulfilment and tracking of movements; and warehouse management and physical inventory control, including receiving. An airline must also carefully control many regulatory aspects, including technical records of parts, quality control and hazardous material control.

Material management is linked with many aspects of engineering and maintenance operations, so it cannot be viewed in isolation. Many airlines make the mistake of trying to separate IT systems for materials from the rest of the MRO environment, and so create problems, disconnects and data 'silos' that have contributed to inefficiencies and higher inventory holding. A classic example is configuration management. An explanation of how modern IT systems can manage sophisticated aircraft and assembly configurations was given *(see Aircraft Commerce, February/March 2005, page 47)*. Systems to improve inventory management can yield large savings in inventory and related costs. Airlines considering a modern IT system should expect 5-25% inventory savings, based on various industry studies. If the airlines' starting point is poor, then the percentage will be higher. The savings, of course, will take some time to be realised. The means whereby these savings can be realised through IT systems are discussed.

There is a danger that the wrong inventory will be reduced, however, which will soon ground aircraft that are short of rotables. The relationship between inventory holding per aircraft and technical despatch reliability is illustrated *(see chart, this page)*. This indicates some typical metrics for inventory holding for an airline that undertakes its own maintenance. The graph plots several airlines from Europe and the US in terms of their inventory holding per aircraft against their technical despatch performance. The airlines in this sample have fleets of 15-100 aircraft. The best performers (green zone) manage to lower inventory levels while maintaining a high technical despatch reliability. These airlines are holding $1.0-1.5 million of inventory per aircraft.



Other airlines have driven down inventory, but have sacrificed some technical despatch performance (bottom right quadrant).

Others hold significant inventory and get a good despatch rate in return. These airlines have yet to master the art of holding the right mix of a smaller, selective inventory, and are wasting costs by holding too much of every part.

The worst airlines hold more than $2.5 million of inventory per aircraft, with the worst case scenario being an airline that is in the top right-hand corner. They hold a lot of stock, but most seems to be the wrong part numbers or to be in the wrong place, since the airlines suffer from part shortages, which cause delays. This is a classic problem of an airline with either an old MRO system, or a collection of disconnected systems and home-made spreadsheets providing little or no management information to help drive inventory down. It also indicates a poor demand and distribution process.

So how do the good airlines achieve their inventory levels and high despatch performance?

Parts provisioning

A cornerstone of good material management is planning and forecasting. Spares provisioning is an extremely complex process because 80-90% of it is sporadic, and so difficult to manage. The intertwined relationship between these parameters and the exponential relationship between holding quantities and fill rates, or the percentage of time that a required part is immediately available, results in a problem with many millions of variables.

Without sophisticated dedicated tools, the spares planner faces the impossible task of provisioning for spares in this complex environment, resulting in poor fill rates due to shortages, poor aircraft despatch rates and extended aircraft-on-ground (AOG) downtime. A variety of IT systems is available to assist.

Lawson, from the US, emerged as a new name in the MRO market in 2006. Lawson is the re-branding for Intentia, which has been supplying MRO software for many years. Intentia's product was called MOVEX. Now merged with Lawson, the product is called M3.

"Material management is a particular strength of M3 and we see the start of the process as planning," says Patrik Hillelson, industry manager of MRO at Lawson. "The concept for materials is based on classical material requirements planning (MRPII). This includes the planning of known material requirements for rotables and consumables and unscheduled material needs based upon probability forecasting. This normally uses inputs of previous failure rates and future aircraft utilisation rates. Obviously the third big factor is stocking policy. In other words, the crucial issue is how much of a safety buffer do I wish to build in to cope with peaks or spikes in demand. One critical concept that IT systems need to cope with is multiple part numbers within an interchangeable family, and across multiple stock locations in an enterprise, including both owned stock and non-owned consignment stock. M3 can model many different forecasting methodologies, but our experience is that most organisations only ever use one or two. The main benefit for an airline or an MRO facility is to provide a high fill-rate for spares demand with the minimum amount of stock."

"The AMOS suite is integrated across all modules, which includes our material management modules," says Ronald Schaeuffele, chief executive officer at Swiss AviationSoftware Ltd. "An important element of lowering inventory is to be clever in the way the computer systems solve a demand situation. The user can choose from 14 different forecasting methodologies, from complex autoregressive moving average (ARMA), non-stationary models like ARIMA or seasonal models (SARIMA), to simpler ones like exponential smoothing and the Holts-Winter equations within AMOS. In all, research shows that ARIMA forecasting is accurate for future forecasting. While these models are complex, AMOS software makes the user interface easy. Data is displayed graphically to make it more immediately understandable. AMOS can also assist planners to better assess re-stocking policy by looking at seasonal re-ordering. For example, if we know we only ever use two of a particular part number, the system will look at lead times and recommend an order point just in time for the demand. The system will also look to contractual constraints or opportunities to reduce cost. Integration into the procurement module is critical to offering this capability. For example, calculating optimal order quantity is based on capital costs, fixed costs per order, service level target and component interchangeability.

"AMOS takes a different approach for rotables and high-value tracked parts," continues Schaeuffele. "We are testing a rotable simulator for release in the next version of AMOS. This assesses what parts I have, how many, where they are located and what are the interchangeability rules. When a demand

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is forecast, the system will economically assess how to satisfy it. The user can load the IATA (International Air Transport Association) standard loan order cost formula into AMOS, for example. AMOS calculates the cost of a loan if there is no stock to satisfy the demand, based on 1% of the item price as a loan charge per day for the first week, and then 2% thereafter. AMOS will also open an electronic reminder and a back order to take the place of the loan item when it is received.

This function also allows for the return of a different serial part against the original loan, if the contract allows. All in all, loan charges can mount up. We have had some customers who lost track of loans and paid five times the purchase price of the part, because they left a loan item on their aircraft. Good loan management can reduce rotable costs by 3% of total annual budget. This can be worth a lot for little or no effort with a new software system. The next challenge is to tackle mixed ownership. There is a growing trend for leased stock, consignment stock and parts pooling. This presents airlines with the challenge of managing and tracking these parts separately, to ensure they are handled appropriately in line with contractual obligation, and to ensure that financial valuations of stock are correct. Users of AMOS can add an ownership code to a part to identify its owner."

Improving forecasting

What options does an airline with an old legacy MRO system have if it wants to improve inventory management without replacing its entire core MRO software system? There are vendors with point solutions for the problem. These are systems that purely address the issue of provisioning and forecasting, and can be integrated into legacy systems. One supplier is Armac Systems from Ireland, whose product, RIOsys, is a spares provisioning tool for provisioning and forecasting. RIOsys can save companies millions, both in reduced investment and improved spares availability. There is a balance between volume of stock and the costs incurred by lacking inventory when required. The goal is to find the optimum cost point for an operation.

RIOsys works with existing material planning systems and is easy to use. Installation, integration and training can be completed in days. It offers an alternative to a major IT project, but generates a fast return on investment. It focuses on optimising inventory, while maintaining fill rates to match maintenance demands and good technical despatch reliability, and on eliminating surplus inventories and dead stock. "RIOsys can increase fill rates and service levels by 20%, while reducing inventory investment by 40%," claims Micheál Armstrong, chief executive officer and founder of ARMAC. "These benefits are achieved without additional capital expenditure, since the investment is leveraged. The return on investment is almost immediate. Customers include SR Technics, which launched the product."

Configuration and part data

Part master data, and the Illustrated Parts Catalogue (IPC) in particular, need to be managed to maximise the benefits of modern IT systems. This is the second big lever with which IT systems can help management control. But how easy is it to keep the data up to date?

"No one wants to update the entire IPC database every time the original equipment manufacturers (OEMs) issue revisions," says Hilleson. "But M3 has a data import tool if anyone wants to. One of our customers, SAS Technical Services, has taken a subscription to get prices and new parts data from Continental Graphics on-line into MOVEX, now M3."

Schaeuffele from Swiss AMOS agrees. "We can upload the IPC into AMOS, but the reality is that a mechanic is obliged to view parts in the OEM's IPC any way. We can make the IPC available in AMOS via a link, using Jouve, eDOC or the OEM's own software. But adding new part data in the AMOS database is done manually by the engineering department. It is their job to assess what part supersedes another, what the interchangeability rules are, and then set up the part master data in AMOS. It is not an automatic process. It is quite normal for new parts not to be e-loaded into AMOS if they are alternative and interchangeable. The airline takes the unknown part number and adds all its engineering and purchasing data into AMOS once it has been ordered by a mechanic. While this takes time, it is more efficient than loading every conceivable part into the system, just in case someone orders the part later.

Logistics

If an airline can move stock more rapidly, it will achieve three benefits: lower overhead costs; lower work in progress (WIP); and so, ultimately, less inventory. High inventory does not always result in higher operational reliability, however. The right parts need to be moved to the right place at the right time. There are several elements to good logistics management, starting with the receiving process at a location, but also including the visibility of a part's physical position.

"Receiving varies widely between airlines around the world," comments Schaeuffele. "Somebody receives, inspects and certifies the part for release. Larger organisations can have three stages to the process: one department receives and un-boxes parts; a second inspects paperwork, looks for damage and deals with any discrepancies; and a final group performs airworthiness inspections and release.

"Systems need to be adaptable to each situation," continues Schaeuffele. "AMOS can provide visibility for all stages, and parts move electronically through each process. Our sister company Swiss International Airlines has single step receiving. Qualified inspectors receive items, complete checks for service bulletin and modification status, check serial numbers, and enter batch numbers. They also complete customs data entry. Barcoding is used in all stages to make the process efficient." While barcoding and mobile handheld devices are widely used in the material area, radio-frequency identification tags (RFID) are still some way from being useful *(see The application of handheld devices in MRO, Aircraft Commerce, October/November 2005, page 48)*.

"AMOS also allows the user to identify parts that are required for AOG situations in particular shipments, and to track the shipment on-line via the shipper's web portal," adds Schaeuffele.

Goods receiving and shipping management can shave a day or more from the turn around time (TRT or TAT) of an item. This can be worth 2-3% of the total material budget, presenting another cost-saving opportunity. The management of part movements through a dispersed airline enterprise, after receiving, is complex. Deciding which parts to place where, and when, can affect stocking levels by as much as 10%. Most modern IT systems can model an enterprise, and set up location points to move parts internally. "AMOS tracks part locations and movement history,

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since it is a regulatory requirement," continues Schaeuffele. "We even track the internet protocol (IP) address of the computer that did a booking into a particular location, since we are a web-based application. There is a limit to the granularity of movement tracking, however. For instance, there are no electronic locations between stores issuing the part to a mechanic and the mechanic fitting the part to an aircraft. The part is simply marked as 'issued to maintenance'. It will hold the information about which work order it was issued against, which tail number it is for and which mechanic received the part. That is usually good enough to trace the part location."

There are other areas where a system helps to manage the complex material world, and create savings.

Warehousing headaches

The biggest challenge for a material department is the warehouse. While many warehouses have sophisticated automated picking and stowage, and active RFID tags with handheld technology, this reality still seems a long way off for many airlines.

There remain many aviation warehouses that lack barcoded warehouse bins, and use handwritten labels for stock. "Most airlines have very unsophisticated stores," explains Schaeuffele. "The bin information, for example, does not indicate bin size or weight limits. Why are airlines so behind on warehouse technology? The answer is that their business is not the same as WalMart's, and there is a lack of standardisation across the industry. An airline warehouse deals with inward and outward parts, unserviceable parts, legal requirements for control of handling, managing internal routing, and external routing of parts. Issuing of parts is a good example. When a demand for a part is received, picking would normally be done on a first-in-first-out (FIFO) basis. But this may not be appropriate for an airline, depending on the shelf life and condition of the item, such as whether it is repaired or overhauled. RFID tagging is another example. It is great for the OEMs, which can manage a manufacturing environment, but is RFID tagging worth it for an airline that deals with a range of parts, some with or without tags? There is a lack of standards, and the airline faces significant hardware investment to read and manage tags. Barcoding is high-tech for many airlines.

"Stock-taking or physical inventory management is another area where airlines can gain from modern IT systems," continues Schaeuffele. "The starting point is clean data for the receiving and issuing of parts, and plenty of computer-based validation of any transaction, so that we minimise the chance of errors in stock level data. AMOS runs a standard 'ABC' type analysis, where it bases the analysis of stock on relative valuation: A for high, B for medium and C for low. The system can undertake a rolling stock-take of physical inventory by taking mini-stock takes of small areas of a warehouse on a regular basis. This may be appropriate for the high-value, or fast-moving items. It can do spot checks or samples of inventory for high-value parts, or parts where fill rates are dropping below target levels. The periodicity of checks can be automatically set. Another nice feature is helping the store manager with resource allocation. AMOS can be asked to recommend a stock-take for less than 100 components, or one that will take two hours. We can also ask the system to tell us about consumption or issues that have taken place during the stock-take. This is automatically factored into the reconciliation. We never freeze a location while we perform a stock-take; that is very old-fashioned. The warehouse is there to serve its maintenance customers, and we never tell customers we are closed for a stock-take. The issue of lost or dead stock is one that many airlines still struggle with."

Good physical inventory management, using modern IT solutions, can reduce inventory costs by 1-2%, as well as reduce the overhead running costs of managing the warehouse. These savings alone could pay for a modern IT system over three years.

Counting beans

Accurate inventory valuation is a constant challenge for an aviation maintenance organisation. Significant excess cost and time are needed to reconcile discrepancies in the valuation.

Why is this the case? Most airlines have a separate, central finance system and need to reconcile data across an interface with the maintenance department. The problem is less likely with third-party maintenance companies, because they only have one business focus, and the material management processes are a central part of that business. As well as ensuring data consistency across two systems, there is the issue of which method to use for stock valuation. Most modern IT systems use the constant moving average value (CMAV) approach. "AMOS defaults to CMAV for inventory calculations of value," says Schaeuffele. "The majority of our customers use this. CMAV is where the system takes the price at which parts were purchased over a period, adds all the valuations for a part number and divides the total by the quantity of parts to produce an average price. The average is updated with the new data as more parts are purchased, hence the term 'constant moving'. Of course this does not reflect the market valuation of an item. The CMAV is used for balance sheet calculations by the finance department. Some of our customers grab an extensible mark-up language (XML) file of prices and part numbers from on-line providers like ILS, and run this against the inventory held in AMOS for market values. This can be updated regularly to get an idea of the real economic value of a part on the open market, which can sometimes be very different from the purchase price."

Feeling the benefits

What is the gain to be expected from investment in a new MRO IT system? The first is reduction in staff costs. Modern IT systems allow operations with fewer people, for the same or better material performance. This takes some courage on behalf of the management team to put faith in the IT systems.

The second area is in reducing inventory. Schaeuffele outlines the case of one of his customers. "Two years ago a European operator with 30 aircraft implemented AMOS. One big issue it had was the amount of inventory it was holding. Within a month of going live, AMOS was recommending a sell-off of $2.5 million in surplus stock. This was generated from an actual physical stock-take, looking at previous consumption data, and forecasting future demand."

The third benefit is a knock-on saving in procurement for the external part of material management. Having more accurate and trustworthy forecasts means that stock can be bought cheaply ahead of time, instead of waiting to see if it is actually needed.

The final big winner is safety and quality. Modern IT systems generate much greater traceability and auditability, and are likely to prevent the issuing of an invalid or obsolete part to a work order. This is something that older, fragmented systems struggle with.

Summary

Stock and inventory make up a significant proportion of an airline's investment, and add to the running costs of a maintenance operation. Driving inventory down, with the help of information processed by a modern IT system, can be as risky as holding too much stock. Internal material management is an area in which all modern MRO systems do well. There are even point solutions that can be integrated into legacy systems to produce immediate benefits in reducing inventory. Savings of 25% of inventory can be achieved by the best MRO software systems. But making these savings relies on a management structure, and decision-making, to change something based on the information and recommendations received from these systems. Computers can never achieve such savings themselves. AC

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