In the event of component failure while an aircraft is operating, reliable access to parts and components is essential for airlines to maintain consistency in operations. Instant part availability, however, is not always guaranteed due to a myriad of factors. How operators minimise disruption, via various approaches they can adopt to manage inventory, is explored.

Spare parts supply chain management

An event that delays an airline's operation is a vital or 'no-go' aircraft component failing during mid-flight. This can result in an aircraft-on-ground (AOG) situation, with the aircraft unable to operate until repaired.

The knock-on effect can include penalties, lost revenue and shipping costs. Inability to operate an aircraft even for a half-day can have large cost implications.

While it is not possible to predict and prevent all rotable component faults and defects, the sophistication of data analysis today, alongside evolution of parts supply processes, has allowed a number of failure and AOG events to be mitigated.

Such data now exist from the development of engine and airframe health monitoring (EHM and AHM), which supplies live information to update maintenance and flight crew of each aircraft's operational status. Utilisation of the data is beginning to be expedited through the use of well-integrated maintenance & engineering (M&E) software and systems.

Using industry and historical statistics, the likelihood of each individual part, rotable or component failing can be determined by operators. This then influences which items to stock independently in volume, and which parts can be sourced when needed by suppliers. Since it would be uneconomic for an airline to keep a supply of all parts at its home base, it is important to determine requirements to best optimise stock.

Safety is undeniably the priority. While defects may be problematic if arising mid-flight or away from base, some may be deemed an acceptable deferred defect (ADD). The aircraft therefore continues to operate for a period of time, or until it can return to base.

There are various categories of defect, and the minimum equipment list (MEL) specifies the severity. A defect will be recorded in the technical log or cabin log, and then signed off by a line maintenance mechanic for deferred action.

Once the MEL has specified if the defect can be deferred, the aircraft will be permitted to continue its operation, or be deemed an AOG. If permitted to continue in operation, the deferred defect will be classed as an 'A', 'B', 'C' or 'D' defect.

A category A defect will be directed for repair as per the 'remarks or exceptions' column of the MEL. The length of time until repair is required may be shown in calendar time, or flight hours (FH) and flight cycles (FC).

A category B defect must be repaired within three days. A category C fault must be repaired with 10 days, while a category D fault must be repaired within 120 days.

Priority parts

Each part can be categorised as a go or no-go part. Parts are divided into high failure rate and low failure rate items.

A go item will not affect aircraft safety status if a fault is reported. The aircraft can continue operating for a certain period. Part repair or replacement is deferred until return to home base, or the next routine maintenance event.

A no-go item has the opposite impact. This is a component or rotable essential to airworthiness, so if failure occurs the aircraft is grounded until a replacement part is sourced (or existing part repaired). These parts are most likely serialised, and tracked for maintenance purposes.

An example of a no-go item is a major hydraulic leak or fuel leak. If main flight instruments fail, many are deemed as no-go. All critical system components and flight controls are categorised as no-go parts.

'Go-if' items are generally parts within the categories of ADDs. An example may be a cockpit window, if delamination is observed. A line mechanic will consult the aircraft maintenance manual (AMM), as directed by the MEL, to check for tolerances to determine if delamination is within limits.

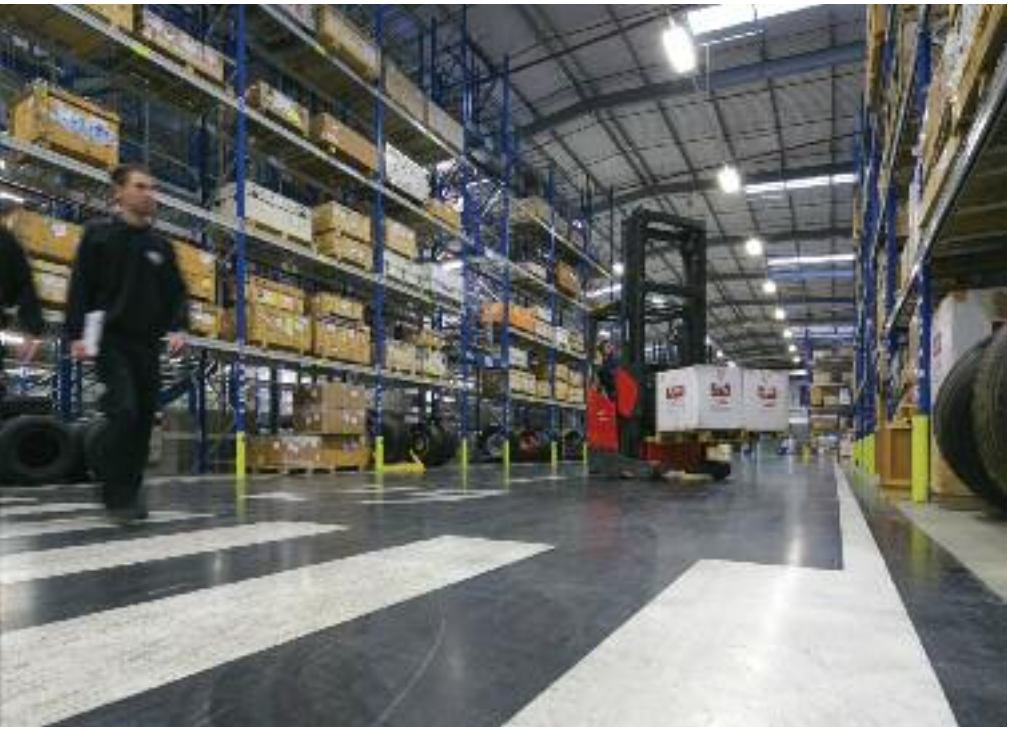
The remaining parameters, high and low failure rate, distinguish the probability of a component failing, using prognostic information and industry trends which will be explored later.

If a part is determined as high failure rate, a mechanic or maintenance planner may replace it with a new part during a routine maintenance event to avoid possible failure. This 'preventative' maintenance still requires investment in buying or borrowing a new part.

Another type of priority part deemed as important is a 'revenue loss' item. This may be a faulty first-, business- or club-class seat. An operator will prioritise this for repair as soon as possible.

Considerations

If a part needs to be shipped from an original equipment manufacturer (OEM) or supplier, it is easy to underestimate the number of individuals involved in the process. "Studying the number of physical actions from an AOG event, through to supplier, customs and security and then reaching the end-user, there are at least 160 touch points in the process to ship one small (sub-50kg) aircraft part,"



AJ Walter specialises in various parts supply agreements and AOG support. Headquartered in the UK, it has numerous hubs at locations including Dubai, Singapore, Miami, Los Angeles and Montreal. Global coverage enables to respond quickly in the event of a customer AOG.

says Ralph Perkins, director at Davies Turner Air Cargo (DTAC) and the Aviation Logistics Network (ALN).

"Inventory represents an essential yet costly component of operations," says Tony Louw, A&D MRO subject matter expert at IFS Aerospace & Defense. "Organisations must carefully balance stock levels, locations, spare parts, service levels and more to achieve optimum performance, while keeping costs low."

Cost influences how operators choose to direct and manage inventory. Given the cost of stocking all rotables, parts and components for a single aircraft, airlines try to strategise stock management. For example, an A380 has about 800 functions on-board, and each can have multiple parts making up its system. A 747 has about six million parts on-board, although about half are fasteners. These numbers show the expense of managing homebase stock independently.

The cost of maintaining and managing rotable inventory, while highly uneconomic for a small fleet, is more easily justified for a larger fleet.

When discussing parts supply packages with a new client, AJ Walter Aviation (AJW) will assess their requirements to determine how best to direct fleet inventory. "We look at the age and maintenance status of every aircraft in the customer's fleet to generate an inventory management prediction report," explains Dan Watson, chief commercial officer at AJW. "We require the 'fit list' for each aircraft type, which lists all components fitted on board. We also look into life limited part (LLP) cycle positions, which drive a fixed demand for parts.

"Another highly important factor is individual operating parameters, such as regions of operation, environment, and FH to FC ratio. For instance, hot, dry or sandy climates will have a different corrosive affect on components compared to arctic or coastal conditions. We stock components exposed to air in the Middle East for example, due to the climate," continues Watson.

AJW also looks at logistical issues, such as where core maintenance is performed, and identifies critical operating hubs that complement a route network.

Third-party suppliers

To maximise flexibility, and ensure access to parts without wasting investment on unnecessary inventory, airlines often rely on partnerships with third-party suppliers. These will ensure that if a part fails downroute or mid-operation, support is on hand to provide the required component.

This access negates the need to keep a large stock of home-based items. Managing inventory of go, no-go, and high and low failure rate items required to support a fleet is complex if airlines want to remain economic.

"Almost all of our 1,500 customers maintain a certain level of in-house spares and rotables," says Andrew Valley, senior vice president of sales at Component Control. "Third-party suppliers are an integral part of supply chain management as well, although the reliance on them to meet regular demands varies based on each company's strategy."

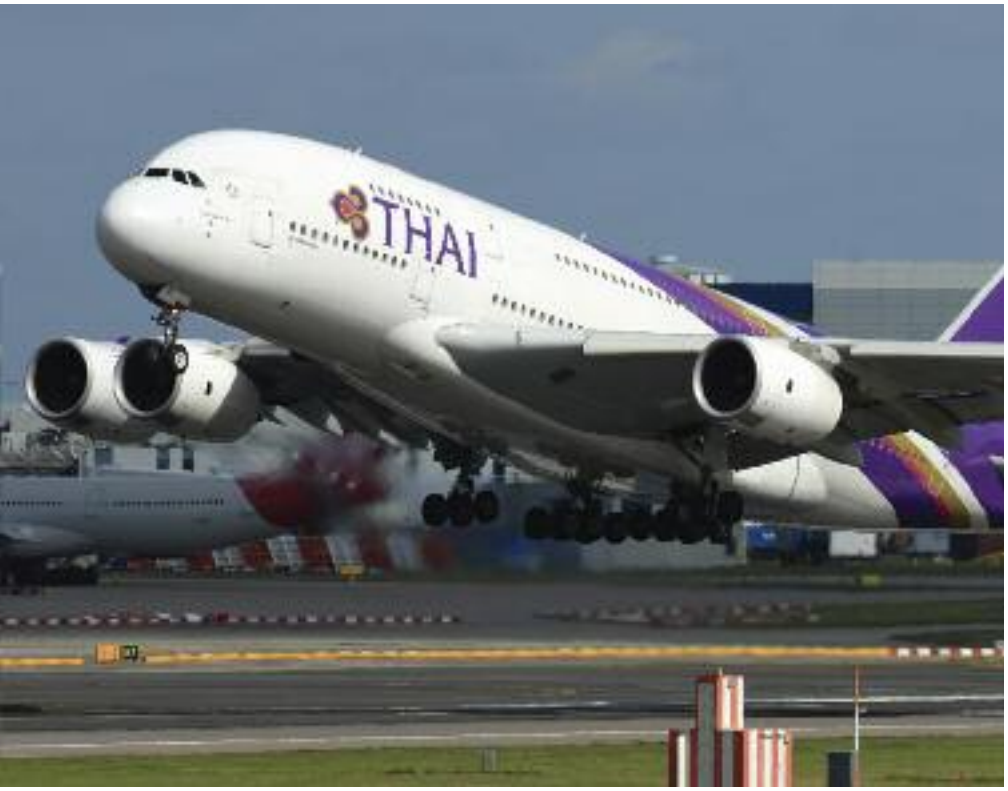
Constant analysis of stock levels, and reliability data is required to assess as and when further part investment is needed. These parameters will shift in accordance with AOG events, operational activity, and base maintenance events. Instead, operators will usually opt to place a significant portion of this exercise in the hands of a specialist third-party provider.

AJW, based in Horsham in the UK, is one such provider. Its primary capability is narrowbody and widebody aircraft parts supply. Airlines operating worldwide comprise 70-80% of its client base. "There are three factors that operators must consider when evaluating the needed level of support," begins Watson. "First, the size of the airline has an influence on the decision.

"The period or number of years over which the fleet needs to be supported also has an impact," he adds. "For example, if an operator is transitioning an aircraft type into or out of operations, using a parts supplier's services will be more cost-effective than the airline owning its own inventory. If an operator plans to operate the fleet for 20 years, however, then it may choose to buy inventory itself.

"Last, individual technical expertise and historic experience may be a factor. If an operator has incorporated a new type into its fleet, for example, it may wish to rely on supplier experience for guidance. Using a specialist provider, such as AJW, allows operators to distinguish which parts should be stored as homebase inventory, versus those that should be deemed essential pool access parts. This is particularly relevant for used aircraft whereupon industry experience is even more applicable," concludes Watson.

Established in 2005 as a joint-venture between Lufthansa Technik (LHT) and Air France Industries KLM Engineering and Maintenance (AFI KLM E&M), Spairliners is a specialist provider of A380 and Embraer E-Jet rotables, parts and general spares. "Our client base consists of airlines," says Fabrice Dumas, head of sales at Spairliners. The majority of agreements managed by Spairliners are near full-scope, particularly for A380 customers. "All agreements to date focus on critical elements in operations, such as no-go, go-if and high-failure rate items," continues Dumas. "Each agreement, however, focuses on the wider need for other less critical parts too. The scope of these agreements is influenced by other factors, such as, notably for new aircraft, OEM influence or investment strategy. This will affect how much external support is needed from an independent partner like us."



The cost of establishing in-house rotable repair capabilities is high for most A380 operators, especially when considered against fleet size. There is also limited used serviceable material available on the aftermarket.

"Another influence is whether the customer has in-house repair capabilities, which would allow it to overhaul and repair components itself," says Dumas. The cost of developing repair capabilities in-house is high for A380 operators, so few have invested in it. "Due to our links with AFI KLM E&M and LHT, Spairliners manages a wider spectrum of repairs in house within its shareholder repair shops."

Aviall is a Dallas, Texas-based supply chain solutions provider. Acquired by Boeing in 2006, it offers inventory in addition to maintenance, repair, rotable and supply chain solutions. Locations include Miami, Los Angeles, Atlanta, Melbourne, Dubai, Singapore and London among others. "Aviall partners with leading manufacturers to offer a broad selection of components to the industry, from shop supplies to engine components," says Eric Strafel, president and chief executive officer. "We develop and maintain distribution service agreements that are true partnerships for both the OEM and Aviall."

Aviall has also established access to a wide range of used, serviceable inventory, offering economical solutions to customers with maturing fleets. "As market conditions have evolved, and customer requirements have changed, we have implemented a used serviceable material (USM) service for engine spare parts," continues Strafel. All products are certified to meet approved OEM repair standards. "The new service supports GE CF34-3 (RJ100/200), GE CF6-80A (767), GE CFM56-3 (737 Classic) and Pratt & Whitney Canada 901A (747-400) engines," adds Strafel.

Parts packages

There are several service packages that are most frequently offered to airlines by MROs and parts suppliers. The package that an airline adopts will be mostly affected by its level of in-house capability. Key contracts are power-by-the-hour (PBH), pool access agreements, loan/exchange agreements, and component MRO services. "PBH can be offered for all types of go, no-go, high and low failure rate parts and components," says Watson. "This service is usually charged to the customer on a monthly basis, reflective of FH flown.

"Component services can be provided on an individual, ad-hoc basis, or via full ATA chapter coverage agreements," continues Watson. "These can be via time and material (T&M) agreements or on a fixed-price basis. Homebase kits and pool access agreements can be on exclusive or non-exclusive contracts, and the kits can be stored at either the main base or key critical hubs for the operator."

"All pool agreements are long-term exclusive agreements that cover critical parts and homebase stock," explains Dumas. "Loan agreements tend to be on a case-by-case basis, predominantly AOG support. We lease homebase stock to about 80% of our customers," he adds. "Pool access agreements are typically charged per FH, and homebase leased stock is charged as a monthly fee. Loan agreements are more ad hoc, with customers requiring service occasionally and mostly in AOG situations."

Aviall provides a global repair management service that includes battery services, hose assembly and fabrication, paint mixing, wheel and brake services, and chemical management. "We also offer rotable management services to customers. These manage pools of overhauled and serviceable spare rotable assets, allowing customers to access parts when needed, without the costs of maintaining inventory," explains Strafel.

Managing supplier inventory

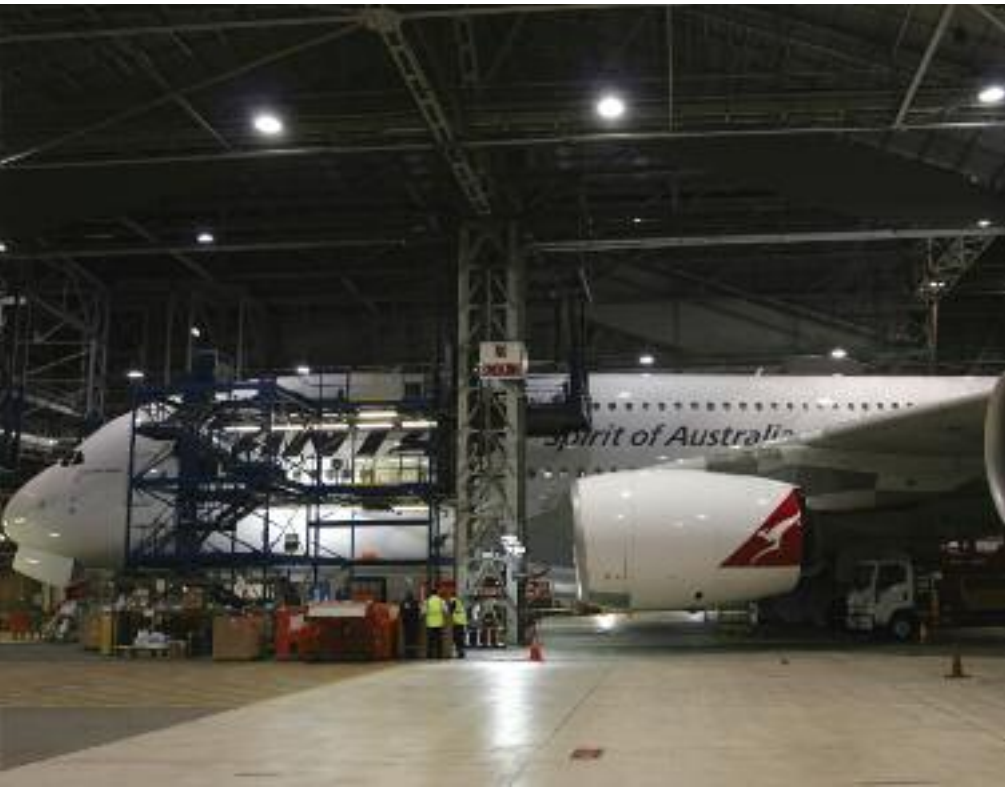
In supplying parts to operators, lessors and MRO providers, managing core stock is obviously crucial to ensuring that parts are always available.

Parts can be bought directly from an OEM as brand new stock, or can be acquired as as-new components or USM resulting from teardown. USM is particularly useful to mature and ageing aircraft fleets, such as the ATR 42 or 737 Classic, where the need is for parts with serviceable life left, rather than brand new or zero-timed parts that are expensive and uneconomic for older types. If a specialist parts provider's capability covers ageing and mature aircraft types, it is likely that the bulk of its inventory can be acquired cheaply through the secondary market.

Another way to optimise inventory is to distinguish part synergies. These are parts that can be used on more than one type in an aircraft family, or across several series and variants. "Numerous part synergies allow us to have more than one use for a single component. Upgrading parts is also vital to adapting and maximising our stock potential," adds Watson. "AJW can upgrade components as per the modification standard required, meaning that we can use components from earlier models in an aircraft family in more recent variants, or as a result of a service bulletin (SB) issued from an OEM. AJW's inventory can evolve to optimise customer usability."

In terms of repair capabilities, OEM repair is the most frequent choice for operators. Designated engineering representative (DER) and parts manufacturer approved (PMA), however, are still available on request.

"For the A380, the vast majority of Spairliner's inventory is acquired straight from the OEM," says Dumas. "Since it is a new type and small fleet, there are few USM parts available on the market. The E-Jet is different in the fleet in activity is much higher and already retirements have



Spairliners is a specialist provider of A380 and Embraer E-Jet rotables and parts. Its client base is purely airlines, the majority of agreements with whom are hear full scope. These agreements include pool access and loan arrangements, charged either per flight hour or a monthly fee respectively.

started. So we are able to balance inventory acquisition in between qualifying second-hand parts, and acquiring new parts from the OEM. This enables us to keep our pool at a young age, and include the latest modification standards introduced by manufacturers."

Determining quantity of stock and its location is critical for suppliers. Aviall takes into account key supply chain processes of optimisation, forecasting, and planning to best position and utilise its inventory for customers. "Optimisation refers to part categorisation," explains Strafel. "Generally, this is based on key attributes, such as demand volume, demand variability, order management policies and service level strategies.

"Our forecast process determines future demand quantities over an extended time horizon. Time series statistical forecasting is leveraged for parts with suitable demand variation, the process actively seeks the best performing of a number of statistical models based on lowest error," continues Strafel.

"The supply planning process actively compares our supply position with our demand requirements over time, beyond the part lead time. Safety stock, as a function of demand variability and our target service level supplements Aviall's demand requirements. This process also determines the quantity of product we must position in our global network to support service level performance for our customers. This involves which product to stock, the distribution of part quantity from our main distribution centres and the rebalancing between locations at the part, quantity level," says Strafel.

Last, Aviall's integrated business planning process serves to periodically reconcile different supply and demand requirements from customers. "Examples include operational data from the end customer and capacity loading with Aviall's OEM client," describes Strafel. "The reconciliation of these inputs from our supply chain partners with the part level demand forecast and supply plan can clearly influence what parts we stock, how much we stock and the timing."

Reliability monitoring

Reliability monitoring is influential in distinguishing part requirements. "The more data to analyse the better, so direct access to a worldwide fleet of common-type aircraft, operating under a variety of conditions, enables parts supply organisations to perform detailed analysis of component and part behaviours. "Due to the large amount of data we receive on a daily basis, AJW is able to continually monitor failure modes of components for customers," Watson maintains.

Health monitoring (generating data based on engine and airframe vibration, alongside multiple sensor information) has increased the sophistication of reliability data. Air France is developing a software tool that can assess reliability of some crucial components on-board its A380 fleet. "When taking new aircraft types, operators relied on the OEM for reliability data," explains Dumas. "The main calculation has been until today the mean time between removal (MTBR), which takes into account the number of failures occurring in a part, and the downtime to replace or repair it. Other factors include experience, FH:FC habits and the climate in which the fleet operates. These combine to establish overall part reliability, and provide a provisioning recommendation to support operations. These data were ultimately based on linear calculation models.

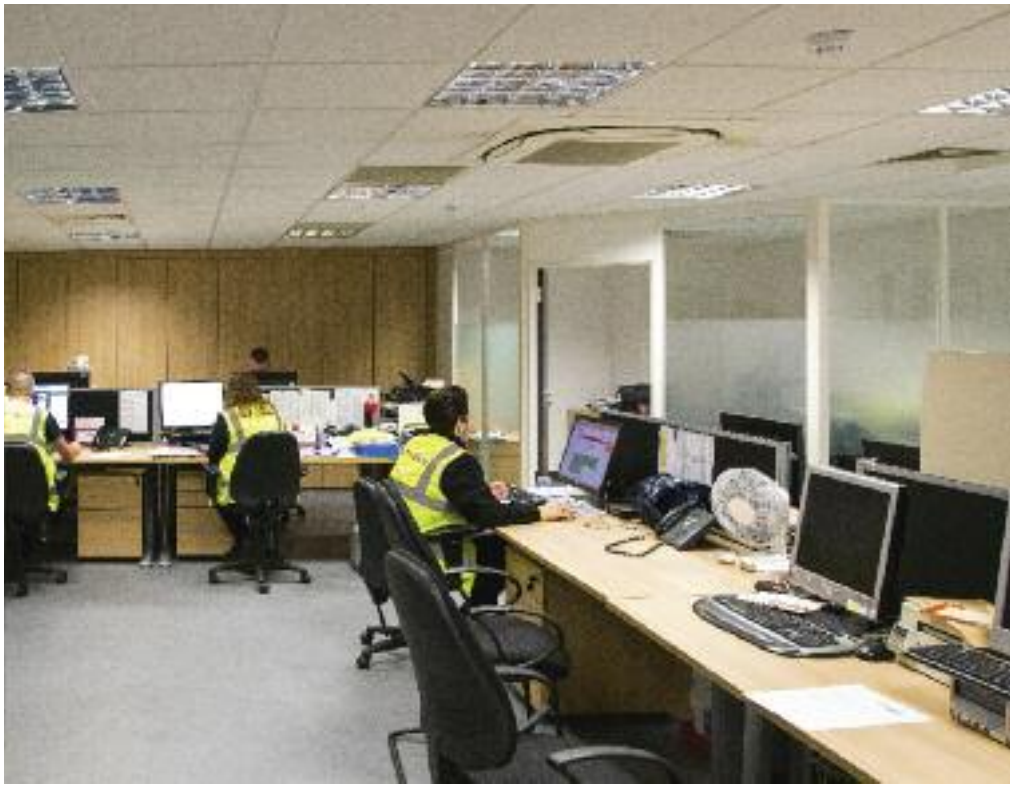
"We now have access to a huge database of removal history information," says Dumas. "We use high-tech tools and big data associated with very complex mathematical models that are allowing us to not only analyse the average removal rate, but also each component's respective removal profiles. This allows more precise removal forecasting, thus enabling us to fine-tune parts investments in association with an expected performance level. This model can be customised and cross-referenced with a customer's individual history to analyse and take into account specific customer constraints."

Big data and its use in reliability monitoring has meant that, even though the size of the fleet supported by Spairliners has increased, fleets have matured and therefore removal requests have increased, the size of our pooling inventory has increased in lesser proportions, and yet overall performance has improved. This is because we have been able to identify much more precisely when to cease investing in certain components, and to invest in the right components that are most required.

Critical supply

One of the most disruptive events in daily operations is an AOG. On such occasions, operators need the required part in time-critical fashion. Typically, the most direct way to contact a preferred supplier is via an AOG hotline that operates 24/7. Global coverage of the supplier is also essential. "AJW has numerous hubs worldwide, including the UK, Dubai, Singapore, Miami, Los Angeles and Montreal," says Watson. "The worldwide coverage offered by these hubs allows us to react quickly in the event of an AOG.

"We also have FedEx and Kuehne + Nagel as service partners," says Watson. "Access to these freight companies allows us to transport time-critical parts within operator-driven timeframes. If freight via land or air is not going to achieve the target, we may even ask a team member



The Aviation Logistics Network is a group of more than 60 companies operating across almost 400 locations worldwide. Each participant is involved in the supply chain process. Operating in partnership with freight company Davies Turner Air cargo, ALN typically sees up to 8,000 AOG events per month. Its customer base mainly requires rapid shipments.

to physically carry the component in question on a commercial flight."

"AOG events by their nature are time-critical, so it has been necessary in the past, although not common, to charter an aircraft to ensure the part reaches its AOG destination in reasonable time," elaborates Perkins. "Most AOGs operate on a next-flight-out basis."

'Time Matters' is the express division of Lufthansa Cargo, and a new strategic partner of ALN. "By using Lufthansa's expertise in fast transfers, ALN will be able to push the boundaries forward with respect to time-critical parts," says Perkins. "An example is Lufthansa's use of electronic airway bills, as opposed to paper forms, which improves efficiency while reducing administrative processes."

If an aircraft is AOG at homebase, or an outstation with maintenance hangar access, an airline may perform a 'robbery,' which involves a line mechanic requesting removal of a component from a common aircraft belonging to that airline which is in heavy maintenance.

Logistics

An industry-wide initiative is crucial to achieving quick transactions and transport in the supply chain. As earlier referenced, there are at least 160 touch points in a typical parts transaction. It is feasible to expect complications to arise at certain points in this process if there is no preparation and organisation.

Established 10 years ago, Aviation Logistics Network (ALN) is a group of over 60 companies operating across almost 400 global locations, involved with avionic, engine and component suppliers, freight companies, and a host of others involved in the supply chain process. "It was important to align the processes of all participants in ALN to truly achieve reactive operations 24 hours a day," explains Perkins.

Operating in partnership with freight company Davies Turner Air Cargo, ALN typically sees up to 8,000 AOG events a month, 350-500 of which may require a hand-carried component. "Our customer base comprises parts suppliers to ensure rapid shipment of parts to MRO providers, lessors and airlines for services such as engine ferrying. Our main focus is naturally AOG, time-critical events and rotable repairs," says Perkins.

"Many complications can arise during standard component transfer," continues Perkins. "These include unavoidable events, such as flight delays and cancellations, airport closures and weather problems. Administrative processes, however, also form a large role in getting a part en route to the customer. Customs clearance, for example, is affected by whether a part is airworthy.

"If a part needs repair, it will often be transported under an inwards processing relief (IPR) certificate, while a serviceable part will be imported or exported under a certificate of airworthiness (CofA) or under end-use relief. Both have different procedural implications and clearances. It can be difficult to ascertain which party - supplier, MRO or operator - should be listed as 'end use'. Establishing this can cost valuable time," continues Perkins. "Another factor is the country into which a part is being imported. If a part is coming into the US it has to undergo prior clearance via an automated export system (AES), which is a different process to other locations globally. Experience in logistics is needed to expedite these processes."

A recent EU action was establishing a scheme to secure international supply chains. Organisations involved in the supply chain process can register as an authorised economic operator (AEO) and, once approved, can benefit from faster customs clearances and simplified procedures. "It is a means for suppliers and freight companies to demonstrate that they are compliant and regularly audited," describes Perkins. To date, the AEO scheme is recognised by the US, Japan, Norway, Switzerland and China.

IT Systems

An IT system that can assess data, integrate across service partners, and provide a single point of data-entry for users where possible is a crucial element.

Davies Turner Air Cargo and ALN offer a cloud-based system for monitoring parts progress. "This is accessed via the web, meaning no installation for users. It enables customers to track and trace parts with a purchase order (PO) number, and access flight and retrieval times to monitor a part's progress," explains Perkins. "It allows suppliers to arrange transportation of a part to an operator. There is a simple booking process whereby users can import or export items."

While it is crucial for freight and logistics companies to ensure rapid booking and transport processes, parts suppliers will require a different type of IT system. AJW uses Component Control's enterprise resource planning (ERP) software, Quantum Control, to manage and analyse inventory data. "Quantum Control interfaces with an airline's own M&E system software to reliably transfer data," says Watson. Quantum Control generates reports based on the vast amounts of data received by AJW, establishing reliability and predictive modelling reports that it can feed back to customers.

"Component Control offers several modules within the Quantum Control ERP designed specifically for aviation aftermarket supply chain management," explains Valley. "These include modules dedicated to inventory management, quotation management, sales and

There are at least 160 touch points in a typical parts transaction. ALN is designed to streamline the administrative demands when shipping components in critical events. Meeting these demands is vital, in order to prevent delays in transporting components to the customer.

invoicing management, purchase and repair order management, among others. Quantum Control also includes direct integration with StockMarket.aero, an online aviation parts trading marketplace that gives users access to a search engine of in-stock parts, MRO capabilities and part alternatives. This allows Quantum companies to find needed inventory and purchase parts without leaving the ERP system," explains Valley. "This aviation trading platform is free for both posting of inventory, and searching inventory.

"Quantum Control provides the tools and modules necessary to manage all inventory-related processes in a paperless fashion," continues Valley. "This includes modules such as: an exchange management module that manages all aspects of an exchange transaction; an EDI module that allows for electronic procurement and seamless sales of material through third-party providers; and a rental leasing module to manage and report leasing agreements."

IFS Applications is an enterprise asset management (EAM) and ERP software suite for the aerospace and defence industry, and markets where manufacturing, MRO, project, supply chain and service functionality are critical. Its solutions also support core enterprise functions for managing finance, inventory and human resources.

"IFS Applications for spares management provides civil aviation organisations with 100% visibility into spare part inventory levels," says Louw. "Planners gain full control of parts and logistics operations, while improving the accuracy of parts and logistics management. This increases efficiencies and minimises capital expenditure.

"The spares management module allows organisations to control, adapt and manage spares stock," continues Louw. The module allows users to browse inventory using various criteria. and also calculates stock levels based on historical usage, and estimates new part minimum/maximum levels, which is required for planning purposes."

Prognostics & data analysis

In addition to the reliability monitoring data provided by systems such as Quantum Control, the concept of prognostic data analysis (data focused on predicting when a component or part will fail or need replacing) is emerging.

All areas in aviation are adopting IT systems that interface with a variety of sources. This now gives access to data previously unavailable via traditional paper processes. Increased sophistication of data-sharing has spawned the concept of 'big data analytics'.

"Big data now needs to prove itself," says Louw. "A lot of information has been gathered and is waiting to be put to use. For real budgetary benefits, the dots need to be joined up correctly in order to understand, not just to draw, the big picture.

"Every flight generates gigabytes (GBs) of data. New and highly sophisticated civil and military aircraft have sensors and data-collection points in almost every piece of equipment on board," continues Louw. "Some of this is being used in the supply chain, but most data are generated without being managed or analysed by the wider support chain of the asset.

"The bigger the data set, the greater the certainty. Certainty eliminates 'guess work' and therefore saves money," says Louw. Big data analytics can benefit operators by establishing the probabilities of a variety of different events occurring." These events include:

- Known Knowns: things we know that we know. Big data analytics will enable operators to validate best practices as and when these arise.
- Known Unknowns: events that we know we cannot predict. Big data will help airlines and MROs to establish patterns to identify and predict these events, helping them to become 'known'.
- Unknown Knowns: An example is weather. Operators know that this will impact operations, but it is difficult to predict to what extent, and when or how often this will disrupt operations. Big data will help develop strategic responses to best counteract these disruptions.
- Unknown Unknown: "These are things we do not know that we do not know," says Louw. 'Access to big data will account for catastrophes and acts of God, and help operators learn post-event 'what to do next time'.

"With the introduction of prognostic data into maintenance operations, information presented by diagnostic data can be used to perform 'just-in-time maintenance," says Louw. In theory, this means that AOG events could be avoided. "If parts are replaced in a hangar ahead of unexpected failure, there is no need to withdraw assets from operational rotations."

Big data analysis has the potential to predict previously unplanned maintenance and can make a huge difference. Picking out relevant data patterns being fed back out of the myriad data being produced through IoT-enabled parts will allow the true benefit of scheduled maintenance to be extended into every aspect of the support chain. More information will be available to understand when parts need servicing or replacing. By feeding this into the EAM or MRO solution, the parts can be sourced and the work schedules of mechanics changed. This means potential downtime can be drastically reduced.

"The ultimate goal in using big data today for the operator, is to predict exactly when a component is going to fail, and for us to ensure that the replacement component is available at the appropriate time," summarises Dumas.

"More data analytics is needed to maximise the life of parts and further optimise the supply chain management

Operators will likely have an agreement with a third party parts supplier. This ensures that if a part fails in operation, technical support is available to provide the required parts. This prevents the need to keep a large stock of home-based items.

process," summarises Dave Lewis, chief technical officer at AJW Walter. "We need to be able to determine what part within a function is going to fail, for example, to achieve this. Big data analytics will be at the heart of this becoming a reality."

E-Enablement & RFID

With electronic flight bags (EFBs), wearable and mobile devices, cloud-based systems and paperless operations, E-enablement and its potential to streamline processes and improve reliability and safety is a hot topic. In the context of a parts supply chain, three key steps are needed to implement an e-enabled parts supply chain. "Step one is to establish a level setting," says Valley. "Inventory reorder points (ROPs) need to be created, and constantly reviewed. Some of this can be automatic, but there is no system capable of calculating report points for all parts without human validation - that is, a completely automated process." An ROP is the level of stock available per part that triggers an action to replenish that stock with a set amount of fresh inventory. It is usually determined by an ROP formula. There will be a different ROP for each part in the aircraft's fit list.

"Step 2 is to authorise E-approval procedures," says Valley. "As inventory is used, automatic ordering is now possible, with a requirement to have approvals at some level. This is most likely to be via mobile applications as part of the e-enablement process.

"Step 3 will involve integration with a vendor's system: ability to electronically place an order in that system. EDI comes close to this, but different vendors will require specific attention,"adds Valley.

"Connecting structured data, such as demand, orders, forecasts and transactions, to unstructured information stored, is key to achieving e-enabled processes," explains Louw. "Unstructured information could be e-mails, calls made, traffic information, and weather forecasts among many other variants."

Connecting all this data to health and usage monitoring systems (HUMS) is integral. "The data collected here can be used to determine when equipment fails and to rectify the fault even before it occurs," says Louw. "From a supply chain perspective, accessing HUMS data could more accurately predict what spare parts are required on which asset. This could positively impact the pooling of parts/components."

Other technologies are available, if interfaced with e-enabled solutions, to overhaul the spares management and parts supply industry. Radio frequency identification (RFID) is a key example of this *(see Tracking components using RFID, Aircraft Commerce, December 2015/January 2016, page 57)*. Although it has been around for decades, RFID is only now being used in the aviation industry. "The use of RFID and other technology presents more opportunities to collect data from sensors in the supply chain," says Louw. Mainly trialled on safety equipment, RFID has yet to reach its potential to track parts and monitor their status. In theory, parts could be transported with an RFID tag that contained their airway bill, maintenance status, EASA Form 1s and other information. These data could transfer between supplier and customer IT systems, establishing part availability and enabling a customer to track a part. "RFID is a good initiative in theory, but the whole supply chain has to be involved to make it work," says Lewis. "This chain includes OEMs, suppliers, repair shops, and logistics and freight companies. It also needs the backing of regulatory authorities and leasing companies."

If RFID could be combined with E-enabled standard operating procedures, such as cloud-based systems and wearable devices, prognostic and reliability data could accurately determine when a new rotable is needed on board an aircraft, which would then notify an operator's M&E system to automatically order a new part. "Ultimately, in the freight forwarding industry no one can agree on standardisation for RFID," says Perkins. "This is delaying further use for it in logistics and the supply chain."

In addition, the use of drones has been proposed for use in transporting parts, although it is too early to say whether this has any long-term potential.

3D printing, however, may impact the need to transport certain parts. As 3D printed and additive layer manufactured (ALM) parts are used in many new generation engines, operators and MRO providers could have on-site capabilities to manufacture them. "All that is needed is the appropriate machinery, and the computer-aided design (CAD) file from the OEM for parts to be manufactured on site," explains Perkins. "The cost of the iron powder required for engine parts is very high, however, and the industry needs to gain greater confidence in the tolerances of 3D printed parts. 3D printing is likely to be more popular with plastic structures and interior-based components."

Aviation will always be at risk of unforeseen events and circumstances. Greater understanding of how to learn from events continues to develop. This has led to an improved ability to mitigate against and avoid certain outcomes.

Dynamism and a will to adopt new technologies are on the rise, increasing sophistication and (in most cases) efficiency. Providing that all areas of supply chain processes develop at the same rate, automation within the parts supply chain will revolutionise day-to-day operations for airlines. AC