Selecting a maintenance & engineering solution involves many complex decisions. One major issue is the choice between a customised ERP system and a pure-play or best-of-breed solution. All the parameters and issues relating to the selection decision are analysed.

M&E solution selection: ERP vs best-of-breed

Choosing a dedicated maintenance and engineering (M&E) system means deciding between an enterprise resource planning (ERP) system, and a dedicated best-of-breed or pure-play solution. Selection and implementation take a long time and involve many considerations.

System architecture

The basic IT solutions set-up for an airline or maintenance, repair & overhaul (MRO) provider manages the core business functions, including human resources (HR), accounting and finance.

This is required regardless of the size of airline or MRO provider. Many of the world's largest airlines and MRO providers, including Japan Airlines (JAL), Lufthansa, Lufthansa Technik, Turkish Airlines and Turkish Technic, and British Airways (BA), have ERP systems from SAP, Oracle and other providers. Smaller airlines have used smaller solutions for their core business functions, with many airlines using several applications.

Maintenance organisations also need a dedicated M&E solution, and have to decide whether to extend their ERP system and accept some compromises in their MRO capabilities, or to install a specialist application and implement it with their ERP, HR and finance systems.

Michael Denis, principal of Aviation Wikinomics, explains that a dedicated M&E system has 15 main groups of functionality: engineering; management of airworthiness directives (ADs), service bulletins (SBs) and engineering orders (EOs); configuration management; maintenance planning document (MPD) and maintenance programme management; maintenance planning and scheduling; maintenance control and line maintenance; sourcing, procurement and material management; heavy maintenance; engine maintenance;

backshop and component maintenance; tools and ground service equipment; repair and warranty management; and regulatory compliance.

There are several more specialised areas: material forecasting, and reliability and documentation management.

Material forecasting predicts the consumable and rotable inventory needed at all the operators' locations. Most M&E systems are poor at modelling the supply chain, so specialist software is often required.

Reliability management feeds into material forecasting because it involves recording removal rates, and keeping reliability statistics. It predicts inventory requirements using Weibull analysis.

Document management has three parts: archiving technical records; storing a library of reference technical manuals; and writing maintenance task cards.

No single solution provides complete M&E functionality, so other applications are needed for specialist functions, such as: aircraft health monitoring (AHM) and diagnostics; engine condition monitoring (ECM); parts and materials sourcing; advanced long-term planning; and forecasting of spares. Each is often handled by separate solutions, which must be integrated with the M&E system, or the core business solution, which will also interface with other functions within the airline, such as flight operations, reservations and revenue accounting. This is the basic system layout and system architecture adopted by many airlines.

The large number of dedicated M&E solutions available fall into two groups: those developed and customised from ERP solutions; and pure-play solutions.

The three main providers of ERP-customised solutions are SAP, Oracle and IFS. Their dedicated M&E solutions have all gone through substantial development and evolution.

The earlier M&E systems provided by

ERP vendors tended to be based on ERP systems developed for core business functions, which were then customised for each airline and MRO customer.

BA Engineering, SR Technics and Lufthansa Technik use customised versions of SAP for their M&E functions. "We have been using SAP for our core business functions since 1997, and use 100 different custom-built applications for various M&E functions at Lufthansa Technik in Germany," says Michael Soetratmo, director of information management at Lufthansa Technik. "We also have 35 subsidiaries and associated companies worldwide, which had a variety of M&E systems, including best-of-breed, in place before becoming part of the Lufthansa Technik Group.

"Our IT strategy is to give SAP functionality to all our subsidiaries so that they benefit from a single solution," continues Soetratmo. "We will set up a second SAP system, version 6.0, for all these subsidiaries in the group to perform their core business functions. SAP has collaborated with HCL-AXON to build iMRO, a dedicated M&E solution and specialised airline industry system that is an extension of the basic SAP system, and an alternative to a pure-play MRO system. Our aim is for every subsidiary in the Lufthansa Technik group to have SAP 6.0 and iMRO 4.0 as a standard IT set-up, within 18 months. It makes sense for us to replace the pure-play solutions currently being used with iMRO, as we have a single MRO solution across the group, integrating all our subsidiaries."

Richard Minney, head of product innovation at HCL-AXON, explains that iMRO is an alternative to a pure-play system within an ERP system. "It should be cheaper and faster to implement than a pure-play system, because iMRO will integrate with an ERP system that carries out core business functions more easily. No airlines have interfaced with an ERP

system in the same way. Interfaces between best-of-breed and ERP systems have been customised. There are up to 750 interface connections between ERP and M&E systems."

iMRO was built on SAP business suite version 6.0, which is now four years old. The current version of iMRO, version 4.0, was released in January 2010, and version 4.5 will be released in December 2010. Malaysian Airlines, Garuda, Jet Aviation, Boeing Shanghai, and Goodrich aftermarket activities all use the full SAP solution for core business functions and iMRO for M&E activities.

Oracle is the second largest ERP vendor, and offers a basic ERP system for core business functions. It has developed cMRO, a customised M&E solution, from Oracle's basic ERP system. "cMRO was built nine years ago, and the first customer went live in 2006. It is now used by 20 customers, ranging in size from hundreds to thousands of users," says Hannes Sandemeier, vice president cMRO development at Oracle. "cMRO was designed specifically to support aircraft M&E and cover all levels of maintenance. It has the same level of functionality as the most comprehensive pure-play solutions. cMRO also manages some basic core business functions, like HR data, and records maintenance cost data that are needed for the finance function in the core ERP system. Our core business ERP system comprises a suite of modules, called the Oracle e-business suite, from which the user chooses the modules they need."

cMRO's biggest customers are Korean Air, American Eagle, Mexicana and Abu Dhabi Aircraft Technologies.

The main alternative to customised ERP systems are best-of-breed or pure-play solutions. "The key difference between ERP and pure-play systems is that development of the latter starts at a specialised area and then expands outwards to other areas of the business, such as finance," explains Martin Bradsworth, regional manager at Commsoft. "ERP systems, however, start at the outer boundaries of a business, are designed to cope with all main business functions, and then are developed inwards to specialised functions. Their functionality therefore has to be customised for each client."

There are several main vendors of pure-play systems: Swiss Aviation Software, with its AMOS product; TRAX with TRAX Maintenance; MXi with Maintenix; Ultramain; ADT's Wings product; AD Software of France with its AIR Suite; Cimber Air Data with AMICOS; Aerosoft with DigiMAINT; Commsoft's OASES system; and Rusada's Envision product.

The systems from Aerosoft, Cimber Air Data and Commsoft tend to be used by M&E departments of smaller airlines and smaller MROs. Most other vendors provide solutions for larger operators.

A third approach is a holistic one. Ramco is unique in offering a single solution, Ramco Series 5.0, which has both core business and specialist M&E functionality. "Although we started as an ERP provider for other industries, we have developed an aviation-specific system," explains John Stone, director product and market management at Ramco. "Our approach to system structure is unique, because there is no fundamental separation between the core business and the dedicated M&E system. While pure-play systems have been developed from the start as specific M&E systems, all airline M&E departments and MROs still need a second system for managing core business functions. This is why we developed a holistic solution.

"The system is designed to have a network of information flowing between the sub-modules within the system," continues Stone. "Ramco Series 5.0 does all levels of M&E functions, and has been available since June 2009. Its main customers are the airlines of the Republic Airways Group: Frontier, Chautauqua, Republic and Shuttle America. All airlines in the group are using the system for M&E functions, except Frontier, which uses it only for financials. The main advantage is that there is little integration with other systems to worry about. We provide an extension kit when we have new releases and upgrades, because Series

5.0 needs to integrate with other systems. The solution does not do AHM, ECM, or a full documentation and content management service. It does track values and data for AHM and ECM, but operators must use original equipment manufacturers' (OEMS') tools for the full analysis. Ramco also manages technical publications in its e-publications module."

Stone illustrates Series 5's differences with other M&E systems in the detail of its core business functionality. For example, it depreciates all aircraft, engines and rotable components that are managed by the M&E part of the system. This compares to a separate ERP system keeping track of depreciation of assets which are used within the M&E system. "The benefits of our holistic approach can be seen in aircraft configuration and disposal," explains Stone. "An aircraft's value is determined by the maintenance status of its airframe, components and engines. Ramco can accurately track and translate this into asset value. When the aircraft comes to be sold, its exact maintenance status can be produced, and components or engines switched between aircraft if desired. This is much harder with two interfaced systems."

While the Republic Group's five member airlines have five different maintenance programmes, the financials for all five are managed by one computer system and a small team of staff.

Selection issues

When making their decision, most airlines and MROs consider functionality and user-friendliness first, while others will prioritise affordability and price.

Other issues include: which additional applications the M&E system requires; integrating and interfacing them with other applications; the regular upgrades of each application and making them work with all other applications; and the implementation of the system within the user's infrastructure.

These issues all lead to the final cost of ownership of the system, and the returns these inputs will provide. These costs include original software licences, maintenance and upgrades, and implementation and customisation.

A new development is pay-as-you-go software, similar in structure to power-by-the-hour aircraft maintenance. This has already been introduced by Cimber Air Data with its Amicos system, and by MXi with its Maintenix solution. "The idea is to make the user's investment lower than it used to be, because they don't have to pay for software licences," says Rune Hagen, president and chief executive officer at Cimber Air Data. "Users still have to pay up front for data mining and loading to get started with Amicos. We are providing a pay-as-you-go system with our new AMICOS New Generation (NG) product, which will be released in September 2010. The initial investment, excluding the cost of implementation, for installation and licence purchase has been reduced to a quarter of what it was for the current AMICOS 2.0 under the old system. The pay-as-you-go fee is charged on a rate per user-hour, and includes maintenance, upgrades and technical support."

Functionality

"The first thing to realise is that there is no single solution that meets all M&E requirements," says Denis. "There are 15 main functionality groups for M&E, which not all systems on the market can perform comprehensively, and the ancillary functions, such as AHM, ECM, parts and materials sourcing, documentation management, and the

provision of some HR and finance data.

"ERP vendors do not provide aircraft and engine condition monitoring, or content management," continues Denis. "Users have eight main functionality requirements. The first is business processes, which involve modelling workflow and making the application screens follow these to ease and improve the movement of data. The second group is full HR capability. While M&E pure-play systems have some basic HR capability for collecting man-hour (MH) data and keeping track of employees, full HR capability is needed by all users for payslip, salary, tax and insurance calculations. These functions are typically managed by the core business system.

"The third group is finance and accounts. The M&E system collects and provides basic labour and material cost data for the core business system to complete full financials," continues Denis, "This includes: maintaining all sales and costs ledgers, and asset registers; taking revenues and costs from all departments; creating financial accounts; and tax calculations."

These first three groups are performed by the core business solution the user chooses. This can either be an ERP system, or a range of alternative systems.

The fourth main functionality group is AHM and ECM. ECM involves analysing parametric data from engines in operation for computational analysis. This requires specialised mathematical models, to which only an engine's OEM has access, so specialist tools are needed.

AHM also involves parametric data analysis, of fault code data from the aircraft's central maintenance computer. AHM is effectively a fault code reporting system, linked to the M&E system that receives and processes the data.

The M&E system is the fifth group, covering the 15 main areas of M&E functionality described. Pure-play M&E systems are strongest here, with a high degree of functionality, but even they never meet 100% of a user's needs. Some customisation is always needed or even additional third-party solutions to plug in, such as advanced spares planning from companies like Servigistics.

The sixth main functional group is documentation and content management. Content management is the operating system authoring its content with respect to EOs, SBs, work cards, forms and instructions. These specialist solutions are provided by InfoTrust, Documentum, Enigma and Corena.

The seventh main functional area is speciality tools, including AHM, diagnostics and condition monitoring. These are covered by systems such as Airbus's Airman, Embraer's AHEAD, Rolls-Royce's OSYS, General Electric's On-Point and other similar solutions.

The eighth functionality group includes all data or inputs relevant to the maintenance management of aircraft, including crew management tools, electronic technical logs (ETLs), electronic flight bags (EFBs) and time and attendance solutions. "Users often need separate systems for these functions. Data from these are clearly needed for maintenance management," continues Denis. "Overall these eight groups cover 99% of a user's required functionalities. The main trend in IT over the past decade has been towards open architecture and interoperability, as systems' formats have been standardised. All the separate systems and solutions are able to interface with each other and exchange data, so the need for a single system is reduced.

Cathay Pacific has chosen pure-play over ERP. "We started the decision-making process in 2000, and found that Ultramain was the best for us, although we did modify it to suit our needs," says Rob Saunders, manager of the engineering department at Cathay Pacific. "We feel that ERP systems are not good for aviation, because you have to change your business to suit the system. We used Ultramain to replace nine different systems, and migrated a lot of functionality from our old solutions to it.

ERP systems have some cumbersome processes for line maintenance, for example. There are some pure-play solutions that also lack functionality, such as a technical log capability. Systems have to be very slick, with detailed functionality, and to be able to focus on high-volume activities, such as tasks that are performed hundreds of times per day. Another weakness of ERP systems is that they do not accept Airbus part numbers, because they are too long. An M&E system has to be powerful enough to track thousands of parts."

ERP systems were earlier customised to become M&E systems, and underwent lengthy implementation problems. ERP vendors have recently developed their systems to more specific M&E solutions in an attempt to put them on a level closer to pure-play solutions. Oracle claims that its cMRO system has the same level of functionality as the most comprehensive pure-play system. "The four main areas of cMRO are: aircraft configuration management; maintenance planning; engineering data; and maintenance execution," says Sandemeier. "In the configuration management part of the system we have the master configuration for aircraft and engines, based on a tree structure. This is kept for all maintenance-significant positions. There is a template for each aircraft and engine type, which is copied for each tail number and serial number. The flight hours (FH) and flight cycles (FC) for each aircraft, engine and component are tracked, and linked to the fleet maintenance programme."

cMRO plans maintenance all the way from line checks to heavy airframe visits, engine removals and shop visits, and component removals. It can forecast the maintenance requirement for every aircraft based on the maintenance programme and the actual accumulated FH and FC, and generate a schedule of maintenance visits for every aircraft over the long term. Maintenance packages are then created, both for in-house and sub-contracted packages, but this can only be done if maintenance intervals and the effectivity of tasks to particular serial numbers have been defined. The system must therefore be linked to the aircraft's maintenance requirements. "To do this, cMRO inputs ADs and SBs into the fleet maintenance programme," adds Sandemeier. "The system also needs some integration between the supply chain and the maintenance plan so that all required parts are available when checks and maintenance events are due. Manpower and skill types are then planned, and maintenance capacity is analysed and compared with planned maintenance events.

"cMRO can provide a snapshot of maintenance events that are coming due for each tail number and engine," continues Sandemeier. "Besides planned maintenance, the system also captures faults as they occur so that a maintenance requirement can be triggered. The system has to adjust for changes to aircraft schedules and cancelled flights. It also estimates MH and materials requirements for each maintenance visit, captures actual MH and materials as they are used, and fully integrates these data with the finance module. It also manages consumables, materials and rotables. In the case of rotables, this includes tracking and monitoring component reliability to determine the amount of stock needed at each line station and the operating base."

cMRO stores and generates documents for use by mechanics that are using electronic devices, but it does not interpret the contents of electronic documentation. It has a partnership with Enigma for the specialised functions within documentation management. Enigma's solution reads the OEM manuals, parts lists and drawings, performs revision control and comparison, and populates the engineering information in cMRO.

Sandemeier concedes that a hangar or component shop would probably find a pure-play or specialist point solution

cheaper than employing cMRO. "At a higher level cMRO will be faster and more cost-effective, because it can be used as an enterprise system, so there is no integration or communication required with other applications," claims Sandemeier. "Also, there are no problems with constant updates of other applications in alternative systems."

While cMRO can demonstrate a high level of M&E functionality, this is similar to pure-play solutions. Swiss Aviation Software's AMOS product has some of the most extensive functionality of all M&E systems. Its core M&E functions revolve around six main modules: publications; engineering; logistics, maintenance control centre (MCC); maintenance planning; and maintenance production. Two other modules cover the HR and finance functions. "AMOS does some of the basic finance functions such as contract administration, warranty management, third-party billing, financial reports and asset depreciation. The core business finance functions of general ledgers and accounting, cost control, asset management and budgeting have to be done by the core business or ERP system," says Schauffele. "In terms of HR, AMOS manages staff administration, training management and labour shift planning. Salaries, tax and insurance are done by the ERP system.

"The core M&E functions are maintenance planning and production," continues Schauffele. "Maintenance planning requires interaction with flight operations for the planned flight schedule of each aircraft. Maintenance production follows. Items such as components being removed and installed, findings, parts pickslip requests and progress tracking are all done within AMOS. The system gives a graphical groundtime overview, and the execution of different task cards and progress of a check. Captured MH, the resulting non-routine ratio, and materials used can all be followed."

MXi's Maintenix is another pure-play system with extensive M&E functionality. Evan Butler-Jones, senior product marketing manager at MXi, says that ERP systems do not manage and track the maintenance events of individual rotables throughout their lifecycle. "The customisation of ERP systems has rarely worked. MXi's M&E functionality is managed in four main modules: M&E; maintenance planning; maintenance execution; and material management. The M&E module has all the functions of a pure-play solution, so it manages maintenance programmes, aircraft and engine configurations, maintenance records, engineering support, and documentation. MXi also partners with content management systems, such as

Airman, InfoTrust, and Maintenance Performance Toolbox. None of these functions are done by ERP systems, and they have to be customised to do them," says Butler-Jones. "For maintenance planning, the management of facilities and aircraft acquisition is handled by the core business management or ERP system. This is important because facilities' availability and aircraft deliveries affect maintenance plans. The pure-play M&E systems carry out short-, medium- and long-range maintenance planning, as well as scheduling airframe checks and the removal of engines.

"Maintenance execution is an area of M&E where pure-play solutions are particularly strong," continues Butler-Jones. "Part of this is validating the correct parts, documentation and job cards for the check, and managing their sign-off. These are all specific functions to M&E solutions, and may only be done by pure-play systems. Assigning job cards to mechanics, and recording the MH and materials used, can all be done by ERP systems.

"In terms of materials management, ERP systems are adequate for dealing with general supply issues, but pure-play solutions are more suitable for regulating and calibrating parts and tools that have airworthiness requirements," adds Butler-Jones.

Other vendors of pure-play solutions include Cimber Air Data and Commsoft. "Cimber Air Data's AMICOS has all M&E functionalities in a single solution. Clients have add-on systems for HR and finance. AMICOS has some limited core business functionality, however," says Hagen. "The system measures the cost of in-house and third-party MRO work. HR functions are limited to a personnel register, which is a necessary element of M&E. Potential clients are looking for an M&E system, not a complete IT system, which does not exist anyway. Our system is capable of meeting most M&E needs, and in many cases airlines and MROs are still replacing their legacy systems."

AMICOS is more suitable for smaller airlines and MROs, as reflected by its main customers: Cimber-Sterling, ITS, Blue 1, Air Greenland, Croatia and Jade Cargo. "The high cost of licences and implementation of ERP systems means they cannot compete at this level," says Hagen. "Our clients use various systems for core business functions, and most do not use ERP systems.

"We are about to release AMICOs NG to replace AMICOs 2.0," continues Hagen. "This is based on the same Oracle platform as before, with the all the data processed with the Oracle database, and a new graphical user interface (GUI) on top. This gives it a different appearance,

with better graphics, and makes it easier to use. The functionality of AMICOs NG will be consolidated, with many screens being combined. We have also set up an advisory board to make decisions on improving system functionalities. Existing customers will get AMICOS 2.0 replaced with AMICOS NG. We have developed the M&E functionality and capability so that the system can now be used by larger MROs and airline M&E organisations."

Commsoft's OASES system is also more suitable for smaller operators. Bradsworth explains that development of OASES started with the key technical functions, before expanding outwards to a limited extent to other linked business areas such as finance, HR and operations, to make implementation easier. OASES is also primarily used by smaller operators, such as Air Baltic, BMI, Blue Air, Adria Airways, Loganair, BA Citiflyer, Virgin Nigeria and Air Moldova.

Implementation

As described, earlier ERP systems were not specifically designed for use as M&E systems, and have been customised for such purposes. In contrast, pure-play systems have their specialised M&E capability, so there is limited or even no need for customisation. Pure-play vendors all implement their own systems.

This has a large impact on end-users' choice of solutions. Turkish Technic, for example, will use TRAX pure-play solution for its M&E and basic business functions, while parent company THY has already implemented SAP for its core business functions. "Customising ERP systems is very cumbersome. Meanwhile, the best-of-breed or pure-play M&E systems reflect the experience of other MROs, and they are tested and proven, and specifically designed for the MRO business process," says Orkun Hasekioglu, chief information officer at Turkish Technic. "Moreover, we expect it to take only a short time to adapt a pure-play system to our needs, using a team of four or five people over 18 months. This compares to the 35 people that would be working for two years to implement and adapt an ERP system, all paid for by us. We regard iMRO and cMRO as too cumbersome to adapt and use at present. We also feel the pure-play system is more user-friendly, with TRAX having only one screen compared to the ERP system's four or five screens for the equivalent task. TRAX must be interfaced with SAP, THY's core business system. We visited other MROs to see how they managed. Interfacing M&E systems with SAP is common among several MROs, so we do not expect any major problems with this.

"TRAX does not provide all of the

M&E functionality we need, so we have to acquire other applications to meet all of our needs," continues Hasekioglu. "This is the case, however, with all pure-play solutions, as well as iMRO and cMRO. Vendors have developed application programme interfaces (APIs) to integrate M&E solutions with ERP systems. There are also upgrades of various systems that interface with each other. Most upgrades are backwards compatible, so they work with earlier versions of software."

There have been cases of lengthy and expensive implementations of SAP. One is JAL, which spent five years and invested about $300 million implementing SAP. The system went live in the past year.

BA also implemented SAP, including a customised version for M&E at British Airways Engineering. It cost more than $200 million, and BA suffered several technical difficulties before the system was finally fully implemented.

"The long implementation timetables and the huge costs involved with SAP were due to the extensive customisation needed," says Minney. "For example, BA required 117 customisations. iMRO solved this problem with a single-source solution. Oracle has done the same thing with cMRO. iMRO has not completely closed the gap on pure-play systems in terms of functionality, time and cost of implementation, but it has the advantage of being easier to interface with SAP for core business functions, effectively making it one system. I expect that SAP 6.0 and iMRO can be implemented together in about a year for a small or medium-sized carrier, and up to two years for a large national airline, compared with five to six years in the past."

Saunders says that from selection to going live with Ultramain took Cathay Pacific two and a half years. "The time used is mainly for modifications, testing and training. We initially used the system for inventory management only, and maintenance was still handled by our old system. We then gradually introduced our aircraft fleets one by one, to be prudent. The first was hard, and the others much less so. It took almost two more years for the M&E part to be fully operational."

Opinions on implementation costs are clearly divided. "The cost of the basic SAP software is relatively low, but the customisation a user needs typically increases this by a factor of 10," says Schauffele. "In contrast, AMOS can be implemented in only six to 12 months in small- and medium-sized carriers, but still less than 24 months for larger ones."

Providers of smaller pure-play solutions claim similar implementation timetables. "From contract signing we can be ready to go live in six to 10 months, depending on the size of the client," says Hagen. "Data mining from the previous system and loading to the new system is the time-consuming task. Training and re-engineering the system to the user's requirements also account for a large portion of the time to go live."

Ramco also claims its Series 5.0 application makes for easier and quicker implementation. "It took two years to implement the system at the Republic Airlines Group, which was our launch customer. It should be appreciated that this was for the core business and specialist M&E functions for all five member carriers. There are relatively few interfaces with other applications, which include AHM and ECM, because of our holistic approach, so we have not had SAP's lengthy implementations," says

Stone. "Too many interfaces for big organisations cause most of the implementation problems."

Cost of ownership

The cost of ownership comprises five main elements. The first is software licences. Minney estimates that for a combined solution of SAP 6.0 and iMRO these cost $700-3,500 per user, depending on the size of the organisation, and claims this is similar to the alternative combination of SAP and a pure-play application. Schauffele, however, disagrees, putting the cost of a customised ERP solution for M&E only at one-and-a-half to three times the cost of AMOS.

The second and third main elements are the cost of implementation and customisation, which was clearly higher for earlier generation ERP systems than for pure-play solutions. The cost of implementing new generation ERP M&E applications should be closer to that of implementing pure-play systems, but Minney puts the cost of implementing iMRO at twice that of implementing and customising a best-of-breed M&E solution. Estimates by pure-play vendors are that ERP applications have up to six times the implementation cost of pure-play applications, although this ratio is based only on older generation ERPs.

"While the cost of implementing ERPs will be higher, they do have the advantage of lower interfacing costs in relation to add-on applications," claims Minney. Pure-play vendors, however, dispute this, and Schauffele comments that integration of applications is no longer risky, but a part of daily business, with many standard interfaces available.

The two final elements are upgrades and regular maintenance. Minney estimates annual maintenance to be one-fifth of the cost of the initial licence fees.

"Another main reason for taking our holistic approach with Ramco Series 5.0 is that once it is operating live, it requires fewer people than other conventional system designs, particularly in accounts and IT support," says Stone, "because it is a single system. There are fewer interfaces and potential errors, lowering staff requirements." **AC**