How are M&E systems vendors designing, developing and positioning their frameworks to seamlessly adapt to future customer requirements and changes in technology? What are the considerations and implications for future functionality?

The development & evolution roadmaps of M&E systems

How is the development of maintenance & engineering (M&E) systems driven and how are evolution roadmaps established? System design requires an agile framework which allows for responsiveness to changes in technology.

Software providers must keep abreast of industry direction, including trending topics such as: paperless and automated solutions; mobility and Cloud deployment; interfacing with external systems; the import and export of data; and integration with Predictive Maintenance and Big Data platforms.

Similarly, direction provided by customer requests, both existing and in the pre-sale environment, are key sources of information and must be weighed up against compliance and business value.

Software providers must cater for customers that are at differing phases of harmonisation with their system capabilities.

Trax

Trax's comprehensive software solutions, supporting mobile and cloud products, facilitate the flow of information between its many components, and enable individual modules to be implemented as organisations evolve. The two main product lines are eMRO and eMobility.

eMRO suite incorporates 22 distinct modules that cover core functionality relied upon by an airline or maintenance, repair & overhaul (MRO) operation. The device-agnostic application covers materials, technical, maintenance, financial and quality management. This is typically suited for back-office contexts and an operation with a high number of paper transactions.

eMobility leverages iOS and web-based applications, and focuses on mobility and paperless operations. Trax develops applications purely for Apple peripherals, such as iPads, which contribute to lowering development and testing costs. Moreover, there is a preference in the industry to use iPads in the cockpit, over similar devices, and Trax deploys its own electronic technical log (ETL) via the PilotLog and CabinLog apps.

The product line includes digital documentation, a line maintenance application, digital task card for both line maintenance or heavy maintenance in the hangar, and a warehouse management application for stock management. One of the principal benefits is that they run offline.

"We designed the iPad applications to run off-line from the beginning. When you work inside an aircraft, quite often WiFi and mobile phone signals do not always get through successfully. If there is poor connectivity, you can keep working. It queues everything up, and will synchronise the data as soon as it gets a connection. Off-line is a real bonus," explains Chris Reed, managing director at Trax.

The system is pureplay MRO and has been designed from the ground upwards as an aviation software. It is a three-tier application comprising a database, application server, and client's server, with vertical and horizontal web-scalable architecture. Vertical scalability increases capacity by adding more resources, such as memory or an additional central processing unit (CPU), to a machine. Horizontal scalability is the ability to increase capacity by adding more servers.

"You add resilience by having a scalable architecture. With a two-tier client-server application, you generally only have vertical scalability," says Reed.

Trax uses an Oracle Database. Some of its clients are maximising the system's versatility to perform Big Data and machine learning (ML).

"You can connect anything you like to an Oracle Database. A lot of customers are doing Big Data and Predictive Analytics by pulling data out of the backup database, or replicated database which is updated every few minutes or even in real time from the main database. Users are therefore not impacted by the processing power required to access the backup database. It is starting to become more common," adds Reed.

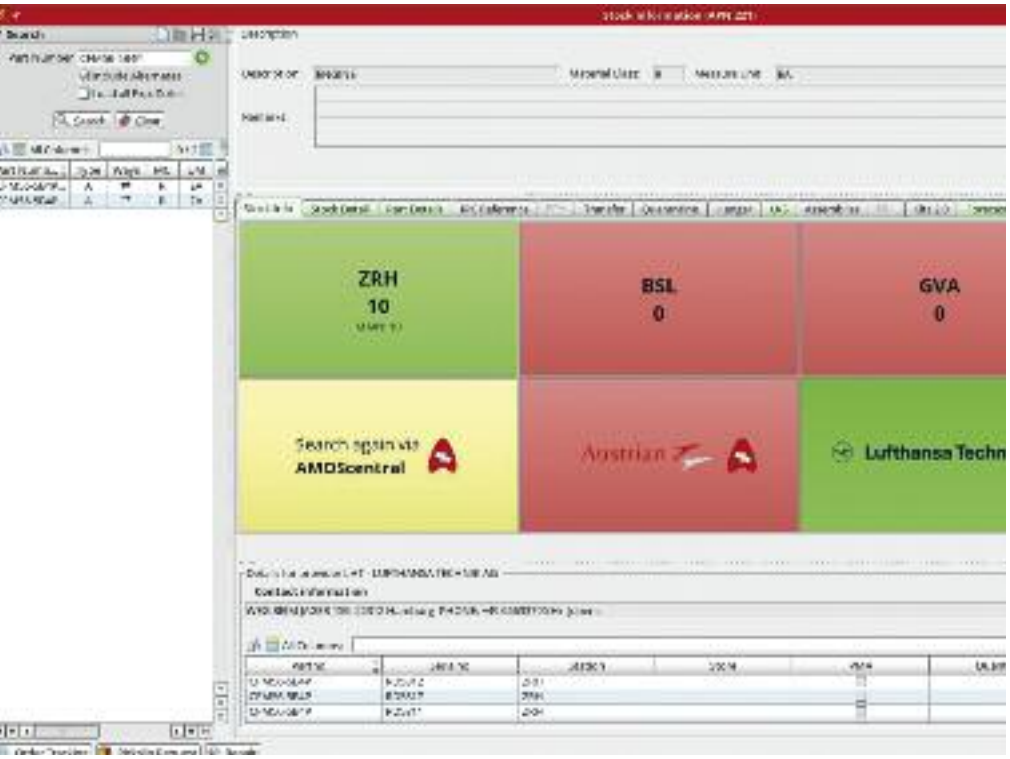
System vendors channel avenues such as user conferences and seminars to demonstrate their latest offerings. These platforms serve to foster innovative ideas and solicit user opinion on the viability of prototype projects in practice.

"We hold user conferences to discuss broader topics, such as technology, and the direction that customers want to go in. We also conduct seminars on specific functionality. The feedback that we receive tends to push the development a lot more," says Reed.

Trax is exploring several avenues of new functionality. They have evaluated augmented reality (AR), using iPads, in the warehouse environment.

"If I am working in the stores, I can hold my iPad up to a shelf and scan all the tags on that particular shelf. On the screen, I will have an overlay of information about those items. For example, it will flag red dots where I have got shelf-life-expired items. Typically, for line of sight, AR works with barcodes. For non-line of sight, you have to use radio-frequency identification (RFID) tags," says Reed.

For customers that want to transition from a paper to a paperless environment,



optical character recognition (OCR) is providing a bridge. By enabling OCR on the iOS application, a paper tech log can be read digitally and the information loaded electronically onto the iPad without the burden of having to type it in.

Artificial intelligence (AI) and ML are being driven to provide capabilities for predictive analytics. One prototype project is looking at historical maintenance data to identify repetitive patterns, via key words, and flag up multiple occurrences as a potential fault scenario. Millions of records can be analysed in a short time, regardless of whether or not they have been coded to the incorrect Air Transport Association of America (ATA) chapter.

Trax draws on its own internal content management system (CMS). The TraxDoc module links to its iPad application called AeroDox. Any documentation put into the CMS can be synchronised with an iPad. Content can be loaded in various formats, including SGML, XML, S1000D, video and audio files. Trax then transforms the S1000D format into its own data and republishes it.

Specifications released by the ATA define standards for content, structure and deliverables with the intent of improving the representation and exchange of technical data. Trax will embody the specifications on a use case rationale.

"As new specifications come out, we will incorporate them into the system based on customer demand. If nobody is going to use iSpec 2200, for example, then there may be some minimal requirements that we have to adapt to.

"The problem is that not everyone keeps up with the standards. Sending data to and from systems relies on a standard, and MROs and airlines adopting that standard. If third-party MRO systems do not use the standard, there is no point in us adapting our system. There has to be a business case for it. As an industry, we need to agree to the universal advocacy of a standard so that records can be sent seamlessly from one system to another. Up to now, we have written customised interfaces to send data to and from third-party systems," says Reed.

A three-tier system architecture lends itself well to cloud-based deployment. Cloud is easily scalable, can be established in multiple locations, minimises up-front costs, and does not necessitate direct active management by the user. Unlike physical IT infrastructure, it does not have a finite shelf life and adheres to the latest technology through updates and upgrades.

"Nine out of 10 of my recent customers all have cloud-based systems. We still have some that do on-premises deployment, maybe due to concerns over security. Your system really needs to be able to sit in the cloud and work effectively in the cloud. That means systems need to be web-based. All of our applications now count on web-based solutions. Cloud is the way everyone is going," says Reed.

Trax essentially focuses on three areas for software development: regulatory compliance, customer developments, and internal developments.

"The key is to keep an eye on technology trends and make sure we are keeping up to date with them. Then, if there is a massive shift, we do not react to it immediately, but evaluate it, and take a decision on what we are going to do. In a regulated industry it is harder to add new technologies quickly. The industry tends to adapt to what happens: we are not futurists," says Reed.

AMOScentral will allow members of the AMOS community to collaborate in an unmatched way by either providing or receiving data sets, or raising data requests over multiple environments according to each member's needs and requirements.

Swiss AviationSoftware

Swiss-AS MRO software solution AMOS counts on a high degree of integration and functional depth, with its scope of functionalities pre-configured in four editions: CAMO Edition, Airline Edition, Airline/MRO Edition, and MRO Edition. It is a pureplay MRO system linking to dedicated financial accounting and operational systems within a customer's ecosystem.

"At the moment, we have a hybrid two and three-tier architecture. This is something which changes. We have a roll-over from one architecture to another. We have AMOSdesktop which has a footprint on the front-end, for the PC user, which interacts with the back-end system and enables high-speed interactions, or high-load interactions rather than going back and forth continuously between multiple tiers. We also support tablet users, especially maintenance personnel, with HTML-based content. For AMOSmobile no installation is required," says Ronald Schaeuffele, chief executive officer at Swiss-AS.

Schaeuffele elaborates on the use of tablets and the association with paperless maintenance, and says that not all organisations, on account of their cultural background, are in a position to completely implement this process.

"We still strive to get the customer into the paperless environment, because there is a big advantage to interacting without paper. This is a continuous effort from our side, and also from the customer's point of view, to introduce this into their traditional ecosystem. Everybody has this in their request for proposals (RFP), but when it comes to really going paperless, there are issues that slow down the process. Most customers are still in a hybrid environment. They are using tablets but, ultimately, somebody still needs to sign off manually. This cannot be called pureplay paperless. The airline industry is not the fastest for adopting the latest technology. At the end of the day, everybody wants to have a piece of paper. This is an area that we are working on heavily," adds Schaeuffele.

Content management is handled within AMOS. The philosophy is to have the main processes contained in the system. An external CMS tool stores documents once they have been created.

For importing and data exchange, the system can cope with Spec 2000, iSpec 2200, S1000D, SGML, and XML. Spec 2500 will be supported by AMOS.

"Data transfer is in the process of being changed. In the past, we had point-to-point interfaces, usually XML-based, but this will be replaced by what we call AMOScentral. We are building a cloud-based message-broadcasting service to dispense with the networking, firewall and configuration issues associated with such interfaces. AMOScentral will not only deal with moving data from A to B, but will also be used to extract and transfer data. Most of the data will be replicated from one AMOS system to another, but it will also help us to exchange data with third-party systems," explains Schaeuffele.

AMOScentral is a Cloud-based platform that allows each AMOS customer to collaborate, according to individual needs, with other members of the AMOS community and beyond. Each member of the AMOS community will act as either a subscriber or a provider of data sets and have a unique registration in the AMOScentral service directory. Both parties will need to agree to the exchange of information via AMOScentral where privacy is guaranteed due to end-to-end encryption of data. No data is stored. Only the parties involved may read the data objects being exchanged.

Initially offered on SAP Sybase, AMOS switched over to Oracle Database, and PostgreSQL, an open source object-relational database.

"Many of our Cloud-based systems are sitting on PostgreSQL. Its features and performance support us with addressing new functionality and technology which are in the pipeline. Most customer installations select PostgreSQL, even large environments with several thousand users," says Schaeuffele.

Most of the Cloud installations are inside the Google Cloud Platform (GCP). We also have Amazon Web Services (AWS) and Microsoft Azure customers.

The Financial Management applications include tasks such as cost and warranty control, invoice generation, and stock value determination. The system possesses extensive analytical and reporting capabilities.

AMOSmobile offers downsized processes for executing line and base maintenance activities. The module is built to operate in real time, rather than rely on off-line capabilities.

"We do not have a complete off-line AMOS solution for use with tablets. Data stored locally requires the building of apps. Due to concerns about cyber security, we do not store data and move it back from the devices. How can somebody make sure that an aircraft will be dispatched in an airworthy condition if they are off-line, and it has just departed? It is a grey area where we want to provide support. This is currently under review, particularly for things that are not airworthiness-related, such as manuals or historical data. But in the end, it will be a mix of off-line and real-time data," says Schaeuffele.

AMOS provides connectivity with open data platforms like AVIATAR from Lufthansa Technik and Skywise from Airbus. It also has partnerships with the industry's biggest names, and interfaces built according to their specific needs.

Interfacing with ETLs is accomplished via Spec 2000, Chapter 17, with products from CrossConsense, ULTRAMAIN, or whatever system the customer is using.

"Customers have asked whether it would be possible to have an ETL integrated into AMOSmobile. This is currently under review. We are building a business case. The results of our community survey clearly show that customers want to have one system that offers full functionality," says Schaeuffele.

"We always want to provide the customer with the level of functionality a modern operation expects: mobility, paperless maintenance. It is all about integrating data, connectivity, and having a seamless flow. From a functionality point of view, we need to adhere to the requirements of regulatory authorities and

OASES MobileMaterial Application for iOS and Android allows stores people and engineers to review stock and issue parts. The application is barcode and RFID compatible and can use a device's camera for these functions.

manufacturers. We invest in our staff to attend industry working groups. We also hold several adoption seminars to showcase new functionality and to evaluate its impact on the customer's organisation.

"The reality is we have to support customers who are working in a traditional paper-based environment as well as those who want us to adapt to the latest technology," continues Schaeuffele. "This is really frustrating for us. The day could come when we have to offer two versions of AMOS. Change is dramatically slow in the industry. We may release a new version or a redesigned functionality, but at the same time we need to continue providing the old functionality for a period of time for some customers. It is difficult immediately adapt to the latest function available in AMOS.

"It is not always about the software, however. It is also about how you treat and support the customer, even though you may not always be in a position to offer the latest technologies immediately. Supporting the customer is as important as selling," says Schaeuffele.

Commsoft

On 10th September 2019, Commsoft announced its acquisition by Montreal-based Valsoft Corporation Inc., a company that specialises in the development of vertical market software businesses.

Commsoft's Open Aviation Strategic Engineering System (OASES) solution has been designed by engineers for engineers. It is a pureplay MRO system with a modular structure. Traditionally, OASES has covered both the continuing airworthiness management organisation (CAMO) and MRO sides of the business. It comprises a two-tier architecture. The application can be hosted on its private Cloud, which is served by two data centres for dual redundancy, or on site by the customer on physical or virtualised servers.

"The Cloud has become increasingly popular. Companies are very lean today. Organisations with limited IT infrastructure find a hosted solution very attractive," says Julian Beames product owner, at Commsoft.

"Most of our new customers this year have gone for on-site or a virtualised setup. Kuwaiti-based Jazeera Airways agreed, at our user group last week, to go locally virtualised instead of using stand-alone servers. It partly depends on bandwidth performance in the region and routing, but is predominantly driven by size. Our policy is to discourage anyone with 15 or more aircraft from going Cloud-based because, by their nature, they will have their own IT structure," explains Nick Godwin, managing director at Commsoft.

The Planning Module can manage Approved Maintenance Programs (AMPs) by automatically importing original equipment manufacturer (OEM) data and attaching job instructions to associated work cards. Manufacturer or authority-issued documents, such as airworthiness directives (ADs) or service bulletins (SBs), can also be created and tracked. Recent developments will see the addition of a Compliance Module to amplify the control and distribution of documents around the organisation.

OASES uses an Oracle Database and keeps pace with advances in the underlying technology.

"Oracle has a continuous process of updating the database. In our next release, we are stepping up from the current version to Oracle 18c. We are also updating the Java and the operating system," says Beames.

There is a focus on being able to handle and exchange data flexibly and economically. Commsoft is seeing an increased appetite for the ability to transfer data smoothly between third parties when sub-contracting maintenance. It has built interfaces to handle iSpec2200 and XML; SGML is not used.

"We want to make it easier to interface with data formats like iSpec 2200, and the increasing use of XML. That is definitely one of the goals that we have going forward, as we see these being adopted more widely. Again, this is an area where we will be driven by customer demand. Certainly, for any new functionality in the future, we will try to force the use of these standards where they exist, especially in terms of interfaces," explains Beames.

"Industry standards always seem to be written after the horse has bolted. They generally appear to apply to newer aircraft, new fleets, and new ways of working. The issue is how to address the legacy fleet which may be five, 10, 15, 20, or 30 years old. You end up with airlines within airlines, managing fleet data in different ways, depending on the data enablement of aircraft, and the data standards they are conforming to. The challenge for us is to adapt to all of those," says Godwin.

The system equally integrates with other software packages, for example, finance and flight operations systems, via multi-level push-pull interfaces. Customers are feeding Big Data analytics programmes like Airbus Skywise. Reliability data is also being uploaded to OEMs. There is capability for ETL interfaces, to NVable and Conduce eTechLog8 solutions, and discussions are on-going with vendors of ETLs and EFBs to integrate their products.

"One of the guiding principles of Commsoft is that we need to be agile: to interface with other best-of-breed systems, and to support single point of data entry," adds Beames.

OASES Mobile is available on any handheld device running Apple or Android operating systems. Deployment is via apps that can be downloaded from their respective online stores. The recent addition of the Mobile Engineer module will cover more of the functions relevant to line and hangar maintenance.

"We are definitely seeing Mobile as the way to go where there is a direct business benefit from having the functionality based on a mobile device. That does not mean the whole of OASES will become mobile. There are some parts of the system that do not currently lend themselves to being implemented on a tablet or a phone.

"We are also looking at web dashboards and debuted our proof of concept at a recent user group. The dashboards provide immediacy of data, refreshing on a minute-by-minute basis, so customers can look at business-critical information. We are moving towards a microservices-based application which allows us to build application programme interfaces (APIs). These are able to transfer this data back and forth between a web dashboard, a mobile device, or another client PC," adds Beames.

OASES gives customers a forward view of the new functionality coming down the pipeline by holding user groups. It employs agile development techniques where the customer is involved throughout the process, and can then directly influence the upgrades, to make sure they integrate properly.

When asked about the future direction of the industry, Beames replies, "Becoming really, truly digital. I would not expect OASES to be producing paper work packs routinely in 10 years time. I think it will be centred on digital data. This will be the ability to pass data back and forth between systems and around systems, with a much greater emphasis on the re-use and sharing of data across systems."

"Our strategic developments look after sub-contractor partners, such as TSS Yonder, which is developing a compliance module for us. This is close to going into service. We have a team handling our mobile applications, and web-based dashboards to accelerate development. And we have our own team in India, KLR Technologies Private Ltd, which performs modifications and strategic development work," says Godwin.

"When we look at developments and options for the future, we have what we call the mod squad or tactical modifications," continues Godwin. "It reviews all customer requests for improvements to the system. We also look at RFPs when we are in a pre-sale environment with a prospective customer. We then weight and score them, and decide which give maximum value to the customer, and on what priority. Our exposure to the market is really driven by customer demand. We recognise that there will be several gears of customer, so we need to be agile and adapt to new technologies, but always driven by delivering business value. We see that people want a more flexible, adaptable system that drives compliance. That is where we are trying to position ourselves. We want to grow organically with our customers."

Rusada

ENVISION is a web-based, device-agnostic, MRO software specifically designed for third-party maintenance providers. It can be accessed via a desktop, tablet or smartphone device. The solution comprises 10 modules that can be bought as an integrated solution, or separately.

It is a pureplay MRO system with the distinction of offering a Flight Operations Module. Rusada can offer a Cloud-based solution, or host through a third-party provider.

"The system is based on a robust framework and three-tier architecture. As a Microsoft partner, we were able to design a stable platform using Microsoft technologies, such as C# 7.0 programming language. The latest version of Microsoft SQL Server has enabled us to design a

high-performance, efficient database. We have also taken advantage of our partnership to develop various analytic solutions using tools such as Power BI to augment our reporting abilities; and R programming language to run algorithms, AI and ML. In addition, Xamarin tools for mobile applications enable us to deliver applications to all mobile platforms," explains Nadun Bentharage, strategic applications manager at Rusada.

"We take a lot of care to provide a responsive front-end design, using HTML5, Bootstrap 4, and JavaScript frameworks, with an easy-to-use interface that allows users to carry out their day-to-day job from any device and any location," continues Bentharage.

Ian Kent, product manager at Rusada, explains that people want to be more mobile and get rid of paper-based records as much as they possibly can, which has been the focus in the industry for a while now. People want disconnected capabilities as well.

"It has been a continual push towards mobility and digitisation of records. We monitor that stream. We carefully analyse what potential new customers are looking for. Requests for information (RFIs) and RFPs are a great source of that, because they tell us in great detail what type of capability customers are looking for. We look to see if we have gaps or areas where we think we need to improve. Then we will use that to feed items into our roadmap development."

Rusada can deploy the application in a mobile environment through a browser with the ability to automatically render to different device sizes. It is now developing specific mobile app-based solutions that can run independently in a disconnected mode. Certain transactions, such as a material request, would have to be stacked waiting for reconnection to the system in order to be processed.

Envision does not link to a CMS. Its recently introduced OEM data engine can import electronic data from the OEMs, primarily maintenance manuals, maintenance programmes, and task card data, in SGML and XML formats, for authoring task cards.

"Over the past year we have been developing the capability to take digital data from OEMs, particularly at maintenance manual and task card level, and to work with digital instructions that are based on source data, rather than authored internally by our customers," says Kent.

"Data transfer and interfacing with other systems is a core functionality. Our infrastructure layer provides excellent scope to interface with external systems through a point-to-point web service, or reading a structured or flat file. Users can also export the data in industry-standard formats such as iSpec2200," explains Bentharage.

Envision can also easily integrate with third-party applications, such as accounting or HR systems, and ETL platforms through the dedicated standard.

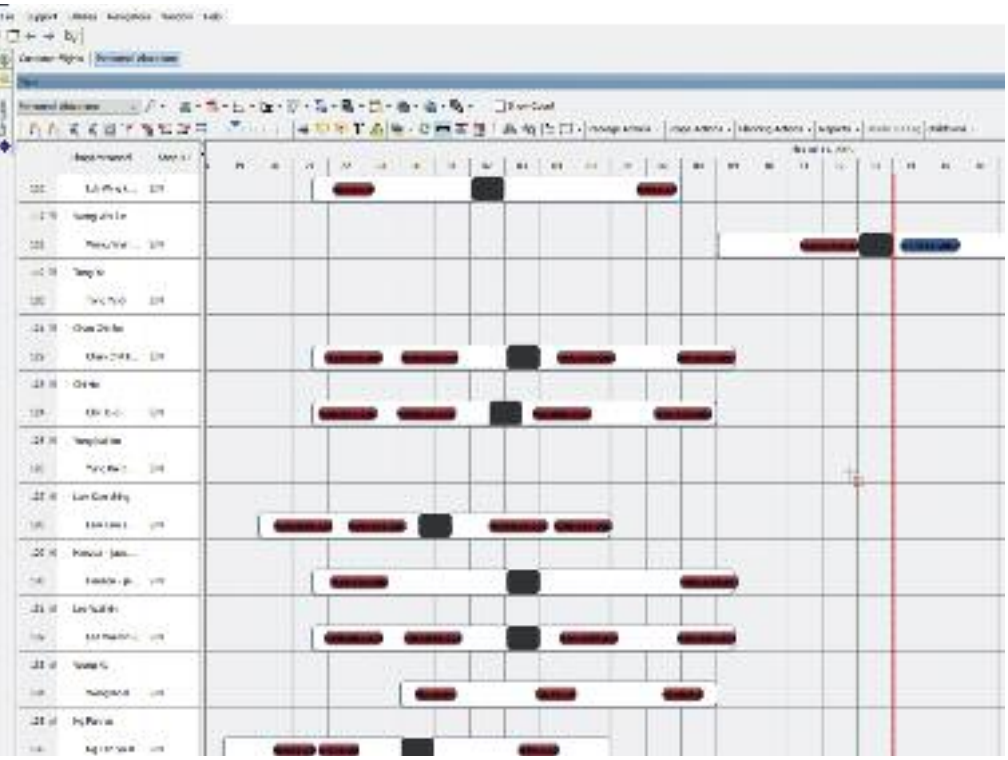
Where do Rusada see the industry heading over the next 10 years? "As a software company, we always plan to use the latest and proven technology for our application and the services we provide," highlights Bentharage.

"In terms of truly going paperless, this has been a real challenge. We have talked about this in the industry for as long as I can remember. I think it will come in the next 10 years. It is a slow industry to react to changes. People have hidden behind the regulatory challenges, because they are scared to try new things. I am still amazed to go into MROs and see them operating as they were when I first started working 30 years ago. The systems behind their business processes may have changed, but largely, they are operating the same way as they always have.

"We have to get over this hurdle of wider acceptance of digital records. It is all very well for a big airline operating on its own to go completely paperless, but it becomes more problematic when you start to cross business boundaries," says Kent.

A blockchain-enabled ecosystem is an unrealised yet powerful tool to provide a digital record of a part's traceability. Blockchain is a digital ledger of transactions, called blocks, that take place on a peer-to-peer network.

"The real potential is the amount of



ULTRAMAIN is focused on automation and enhancing the user experience. Capacity Modeling is one of the most powerful products that allows you to model your constraints, requirements, and timelines, and can generate models using virtually all available data. Via drag and drop scheduling, you can modify the model and then re-project.

data that could be accessed. The complete part history can be tagged. It needs everybody to co-operate in making that happen: the OEMs, component workshops, operators and MROs. When I start to see that happening in other industries, I will be better able to judge when I think this sector might follow. Aviation lags behind other industries massively," says Kent.

Ultramain

ULTRAMAIN is a web-based M&E/MRO software solution. Complementary to its core functionalities are applications dedicated to Capacity Modeling, for long-range forecasting and labour optimisation; Powerplant Management; Aircraft Health and Reliability Management™ (AHRM); and ULTRAMAIN ELB, which is compliant with Spec 2000 Chapter 17.

The software is developed using an open systems approach, allowing it to easily integrate with existing IT systems. Its focus is on usability and long-term sustainability.

The system architecture is three-tier, and can be hosted in the Cloud or internally within a customer's infrastructure.

"ULTRAMAIN is database-agnostic. This ensures our customers are protected from new database technologies and have the choice of database technologies that align best with the customer's technology roadmap and capabilities," explains John F. Stone, vice president for product management at Ultramain.

ULTRAMAIN counts itself as a leader in the realm of paperless maintenance using mobile applications, and was one of the first systems to use the capability. Current applications include Mobile Mechanic™, Mobile Inventory™, and Mobile Executive™. They can be deployed on smartphones and tablet devices running iOS, Windows 10, and Android operating systems.

"It is ULTRAMAIN's belief that the key to increasing efficiency in the MRO industry is the proficient use of mobile devices. Capturing and transmitting the data, at the time of transaction, is at the core of efficiency improvements while performing aircraft maintenance," says Stone.

At its current level of maturity, emphasis is now on using the latest technologies for automation and optimisation, and enhancing the user experience: putting the power of the system in the hands of the user.

"ULTRAMAIN comes with an in-built tool called ActionAnalytics™. As an element of the ULTRAMAIN framework, the ActionAnalytics toolbar is available in all applications and provides real-time reporting and analysis capabilities. This allows users to design and create their own dashboards, reports, pivot tables, drilldowns, Gantt charts, statistical modelling, Excel exports, and analytic and navigation capability throughout the system," details Stone.

ULTRAMAIN integrates with external CMS systems to deliver content, and has the capability to ingest PDF task cards for MROs that may not have direct access to customer content or CMS systems. It has been integrated with various external systems, such as flight operations and accounting packages. Integration with external analytics platforms is also supported.

"ULTRAMAIN's Global Integration framework can be used to create imports and exports of data to external files and systems. Imports and exports can be carried out on a one-off basis by the user, or be time-scheduled by the system. The system records the result of all imports and exports, including time completed, number of records, and any errors and warnings associated with the activity.

"Imports can be created from common file formats, including SGML, XML, CSV, PDF and other standard delimited formats. The framework supports standard protocols like web service calls, FTP, SOAP, REST, and messaging queues, and can configure imports and exports in compliance with iSpec2200. It will also be able to support S1000D, and this will not require any changes to the database structure. Essentially, anything that can be seen in ULTRAMAIN, can be transmitted electronically," explains Stone.

By insulating the Global Integration framework layer from the core system, this has allowed ULTRAMAIN to be responsive to changes in technology.

User forums are a primary driver for future functionality, with evolution also based on regulatory requirements. Internally, ULTRAMAIN evaluates upcoming technologies of benefit to the customer, and ensures compatibility and compliance as they become available. Recent examples include mobility, big data analytics, drones, and voice recognition.

The future

Product development is increasingly aligning itself with customer demand and business value. Seminars, conferences and user groups serve to showcase and appraise new functionality, while industry working groups provide an insight into new technology coming in to the sector.

Software providers must build end-to-end solutions on versatile and agile platforms to be able to address and adapt to future industry developments.

However, the aviation industry remains synonymous with the slow uptake of new technologies, largely due to its highly regulated nature and the inherent cultural behaviour of the incumbents. AC