

Autonomous running may soon be a reality

At a meeting last September at Chesham-based medical gas system specialist, SHJ, key personnel explained to *HEJ* editor, Jonathan Baillie, how the company is increasingly harnessing AI, IOT, and edge computing to enhance its systems to run and fault-find almost autonomously, feeding back fault data instantly should plant begin running sub-optimally, and taking remedial action to restore full performance, often without the need for human intervention. Such is the power of such technologies, that SHJ believes healthcare estates teams may soon be able to leave their medical gas systems to ‘run themselves’. At a second meeting this February, the SHJ team reported on recent developments, and highlighted the features they believe make the company’s installation, servicing, maintenance, and technical back-up stand out.

At an interesting previous meeting last autumn, I met SHJ’s managing director, Stafford Scopes, who explained (*HEJ* - November 2019) how in 1967, his father, Ronald, established the business to provide a more responsive installation service to UK hospitals than was available at the time after a sizeable backlog of such work had built up. The Chesham firm, which has its own assembly facility close to its head office, has considerably developed in the intervening five decades, and, in the past 5-10 years particularly, has harnessed technology including Artificial Intelligence, Internet-of-Things, and edge computing, to give its systems an ‘edge’. Central to one of SHJ’s major selling points – the ability to ‘see’ how customers’ medical gas systems are performing and pre-empt any ‘problems’ – is the SHJ Customer Portal, an easy-to use ‘front-end’, via which the company and its engineers, and increasingly also customers, can access data on the operation, servicing, and maintenance of

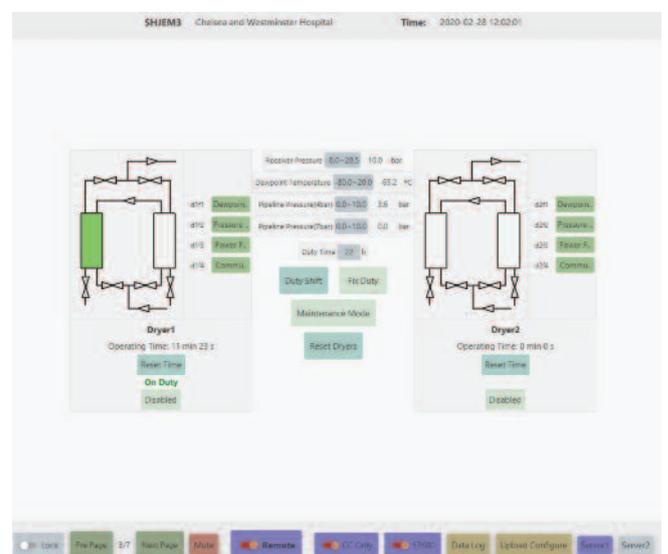
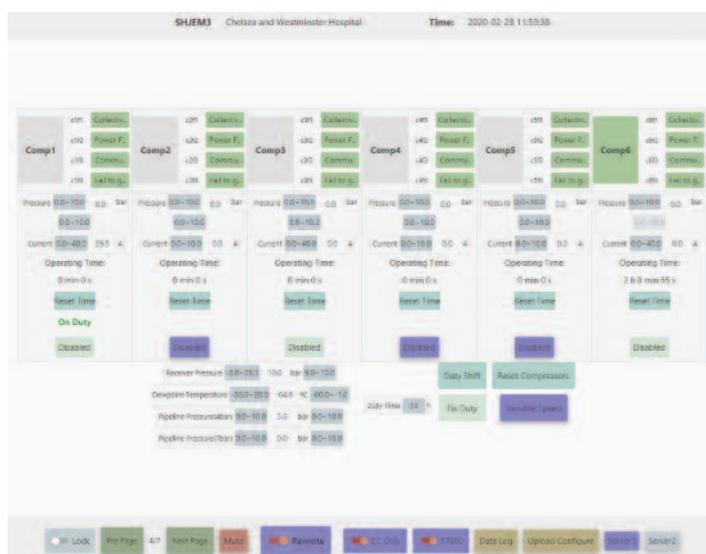


SHJ’s Empower ‘intelligent’ plant control system (shown is the latest version) provides real-time diagnostics, alerts and fault detection.

medical gas systems at single or multiple hospital sites. The portal has recently been enhanced and ‘relaunched’, with a new name, K’nect. The data that the portal holds – in secure, encrypted form – is ‘transmitted’ direct to it either from one of SHJ’s sophisticated ‘intelligent’ plant control/plant monitoring systems, or by an SHJ engineer out on site equipped with a PDA.

Even more ‘intelligent’ plant control and data analysis

Many customers are still using SHJ’s earlier Evolution plant monitoring/alarm system and Empower ‘intelligent’ plant control system on their medical gas plant, but in the past 3-4 years, the company has put substantial work into developing their more ‘powerful’ successors – the Enforce ‘intelligent’ plant control system, and the complementary Emanate Artificial Intelligence-driven data management and analysis software. The development of both new systems has



Screenshots from the Empower intelligent plant controller showing key operating data for a number of compressors.

been spearheaded by Business Systems manager, Matthew Sealy, and Professor Gaoyong Luo; the latter joined SHJ in 2008, and is also a Professor of Communications at both Brunel University in the UK, and Guangzhou University in China. An acknowledged expert in 21st-century communications technology – such as 5G, IOT devices, and edge computing – the Professor has also played a key part in developing and evolving K'nect. While the Empower and Evolution systems have proven a commercial success, SHJ says the new Enforce and Emanate systems, launched this year, offer significantly more functionality and processing power, taking advantage of edge computing and AI in a way the company believes will 'revolutionise' how medical gas systems in hospitals and other healthcare facilities are run – principally because they will be able to detect, very early, when plant begins running sub-optimally, and, in many instances, take corrective action automatically.

Stafford Scopes had explained, when I first met him, that the data on system operation, maintenance, and servicing that Enforce and Emanate provide will also be 'far more comprehensive', while the algorithms incorporated into Enforce will enable more 'intelligent' plant control based on 'trending' – harnessing AI. This will allow users to run their medical gas systems more efficiently, with greater reliability, and lower energy consumption. The new Emanate software, meanwhile, captures data from medical gas plant and uses AI, as SHJ puts it, 'to make fast, reliable decisions'. In future, with the roll-out of 5G technology, and the faster associated data transmission speeds,



Medical air plant in SHJ's production facility in Chesham.

coupled with increasing use of AI, edge computing, and IOT technology, SHJ believes there is no reason why a sizeable hospital's medical gas systems should not be able to operate 'virtually autonomously'.

Never standing still

Time and tide never, never stand still, however, and in the six months since my initial visit, the company had, I discovered, forged ahead with further innovations, including the addition of new functionality to the Customer Portal, and its 're-launch' as K'nect. At this second meeting, senior team members were enthusiastic about the new portal, and the advanced

capabilities of the new Enforce and Emanate systems, but were equally keen to discuss what they feel makes the company stand out – design, installation, maintenance, servicing, and technical innovation-wise. Having met Stafford Scopes and SHJ's Operations director, Phil Hudson, last year (the latter is a former NHS Estates and Facilities director), on this subsequent visit I also met several other key personnel, including Finance controller, Michael Anthony. He began our meeting by explaining that before joining SHJ just over a year ago, he had spent 27 years with Nestlé, mainly working at its UK manufacturing plants. A qualified accountant and Chartered Tax Advisor, he also acquired a number of useful 'operational and logistical skills' at the Swiss multinational, which he said were proving invaluable in his new role. He said: "Having originally focused our medical gas services very much on hospitals in south-east England, we at SHJ are now looking to significantly expand our reach and serve healthcare customers UK-wide.

Pre-empting the market's requirements

"Alongside offering customers the benefits of K'nect," he continued, "we believe we are pre-empting the market's requirements with our harnessing of AI and edge computing. We also pride ourselves on the quality of the suppliers of our key components – obvious examples being the Kaeser compressors and Rietschle vacuum pumps we source from Germany. We can offer shorter lead times than many competitors too – typically of 4-6 weeks – while having our own assembly capability gives us ultimate control over the quality of the systems we ship out. We are fortunate that our pipeline of work is sufficient that we can use our assembly personnel to undertake servicing work as and when required."

A 'backbone' of plant engineers

Service manager, James Forgan, interjected: "We have a backbone of specialist plant and installation engineers who not only assemble new plant, but are also capable of everything from routine servicing to major overhauls. We currently have over 20 engineers covering the UK. We offer a guaranteed four-hour response time, 24 hours a day, 365 days a year, in the event of breakdown or a problem the customer cannot fix." Stafford Scopes had already explained that SHJ offers a five-year 'no quibble' warranty on all new plant. James Forgan added: "This demonstrates our complete confidence in the component parts of our systems, such as the HPC compressors, the Silicair driers, and our control systems. Our plant also has European Pharmacopeia compliance."



The Silicair medical air driers, which use 'a special desiccant mix, which includes a substance used to convert harmful carbon dioxide from car exhaust fumes to CO₂'.

Competent Person trained

Having already touched on SHJ's service offering, James Forgan, who joined SHJ last November, (*HEJ* - March 2020), was keen to discuss what differentiates his Service team from that of competitors. He said: "All our engineers are Competent Person (MGPS) trained, and have strong experience of working across a range of piped medical gas equipment. This is key, because in this sector, you inevitably look after a range of different companies' medical gas equipment. We can service systems from all manufacturers. Most of our healthcare sector plant is under one of our service contracts." Stafford Scopes added: "In fact there is only one SHJ medical gas system out in the NHS not covered by an SHJ service agreement. With Gaoyong's controller and HPC's compressors, though, you really have to know what you are doing. Our medical air driers use a special desiccant mix, which includes a substance used to convert harmful carbon dioxide from car exhaust fumes to CO₂. If one of our medical gas systems picks up carbon monoxide from the external atmosphere, it is turned to carbon dioxide and water. Other manufacturers don't use this system, and we have encountered issues with wet air with some other medical gas systems. Our desiccant mix is a considerable innovation in our air driers."

An HTM 02-01 minimum requirement

James Forgan added: "There is, in fact, a minimum requirement for dryness of medical air as part of HTM 02-01, and our driers comfortably exceed that. All of our engineers have advanced distributor training from HPC, which gives us an unrivalled knowledge and understanding of its compressors. Other manufacturers typically use an industrial air drier design, adapted to use in a medical setting, whereas our drier is bespoke for medical air."

By way of professional background, James Forgan explained that having gained a General Engineering BSc degree at Heriot-Watt University in Edinburgh, he began his career with a seven-year spell as an Installation and Commissioning manager with staff attack alarm specialist, Pinpoint. He said: "Having relocated from Scotland to Chesterfield for the role - in which I covered the whole of the UK and Ireland - I left Pinpoint in 2005 to join Beacon Medaes, as Service manager. I spent seven years there, covering the UK, and providing worldwide technical support. In 2012, I left the company for a seven-year spell as UK Service manager at endoscope washer-disinfector manufacturer, Wassenberg. Then, last November, I joined SHJ. Having met Stafford, and heard about some of the company's key developments, I realised how far SHJ had come in the seven years



SHJ's engineers have a fully stocked van holding spares; these include parts both for its own equipment, and for medical gas systems 'from all the leading manufacturers'.

I had been out of the sector. It would be fair to say I was impressed."

Customer base trebled

Stafford Scopes reiterated that although until about three years ago, SHJ had been best known in the south-east of England, it now serves some 130 hospitals UK-wide, having effectively trebled its customer base. I asked the meeting participants what factors they believed external organisations - including existing NHS customers - would say made SHJ stand out. James Forgan said: "I think principally the competency of the team, and the support we offer, coupled to the back-up we provide via K'nect. We are also transparent in the information that we share with our Service customers. K'nect makes everything we do - from the PPM reports, to the call-outs, to the invoices and quotations - visible, so we have to offer a high level of service."

"We are proud too," Stafford Scopes added, "that a number of our customers have been with us for anything from 20-50 years. We are known for the reliability of both our equipment and our service. Hospitals also know that if they suddenly need help with a medical gas-related issue, they can come to us. We have won much of our work through word of mouth. We also offer an 'emergency' service, via which we can install hire plant very rapidly should, say, one of a hospital's medical gas lines break down."

Longevity and experience

James Forgan said: "Since joining SHJ I have been impressed with the longevity of many of the staff, their excellent

knowledge, and decades of experience."

Central to SHJ's business strategy, and the quality of its 'offer' to the healthcare sector, is the comprehensive data that systems such as Emanate can now provide on customers' medical gas systems. Stafford Scopes explained that a recent recruit, Liu Ping, is in the process of creating a 'Knowledge Base' for the company. He elaborated: "This entails her working to get right to the nuts and bolts of all the equipment we service and maintain, including linking in all the Operation and Maintenance manuals, and ensuring we can obtain all the parts we might need. She is also building up a history of engineers visiting site, and the error codes they might encounter. By identifying and entering onto our database what such codes signify, we can share the data with all our engineers to simplify their task when they are attending to a breakdown. This data will be available to them via K'nect; they all have a tablet on which to do their service reports and feed back information to our back-office computer system. We may also make it accessible to some customers."

James Forgan added: "All the site and plant information - such as serial numbers, locations, equipment etc. - is 'synced' back to the office, and integrated onto the portal, which is invaluable service-wise. A Trust-employed healthcare engineer, perhaps new to a hospital site, can also access the data if, say, a particular component is not functioning optimally, and can then see what work, servicing, and PPM have been undertaken, and look for any 'clues' to the cause."



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Work on 'trending'

The Service manager explained that Professor Luo is currently looking at 'trending'; thus if a particular component keeps breaking down, SHJ will be able to report its entire service history to the customer. He said: "Via K'nect and our AI technology we can provide the service engineer with a comprehensive on-site picture of aspects such as all the servicing work undertaken on the item or component; we can provide this detailed overview for all the medical gas plant connected to K'nect via our plant controllers and monitoring/alarm systems. It's a powerful tool fault-finding-wise, because knowing the full diagnostics history not only reduces the time it takes to rectify faults, but should also increase the number of 'first fix' visits."

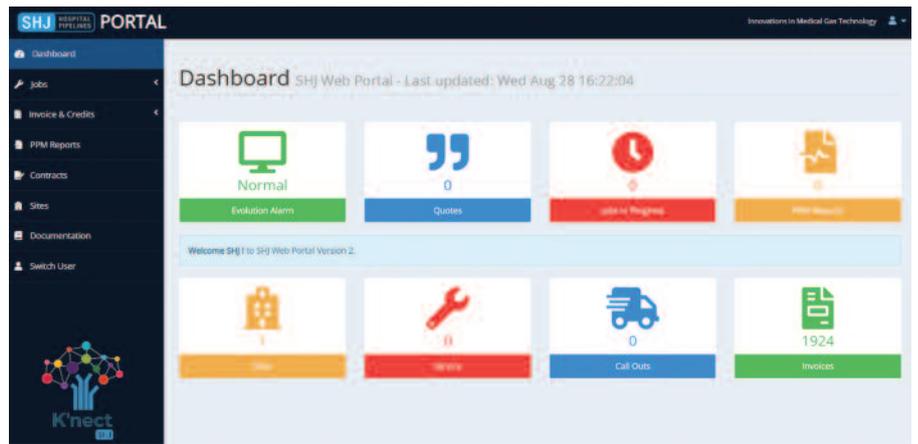
James Forgan explained that all SHJ's engineers have a fully stocked van holding a full range of spares. He added: "These parts are not just for our own equipment; we look after the full range of medical gas systems from all the leading manufacturers. Alongside the stock in the vehicles, we have a substantial spare parts inventory here." "In fact," added Stafford Scopes, "we hold half a million pounds' worth of stock here at head office, plus about a further £10,000 worth per vehicle."

James Forgan said one of his key goals on joining SHJ was to make the company's service offering even better. He said: "We already have a skilled, organised, and well-structured service team, but I am looking to expand it and to continue to upskill the team members. We have a great training and demonstration facility here, with demonstration air plant, and medical gas outlets." I asked what level of skills service engineers recruited to SHJ would need. James Forgan replied: "Everyone needs a CP, but typically you are looking at people qualified to HND level; perhaps City & Guilds for electromechanical backgrounds."

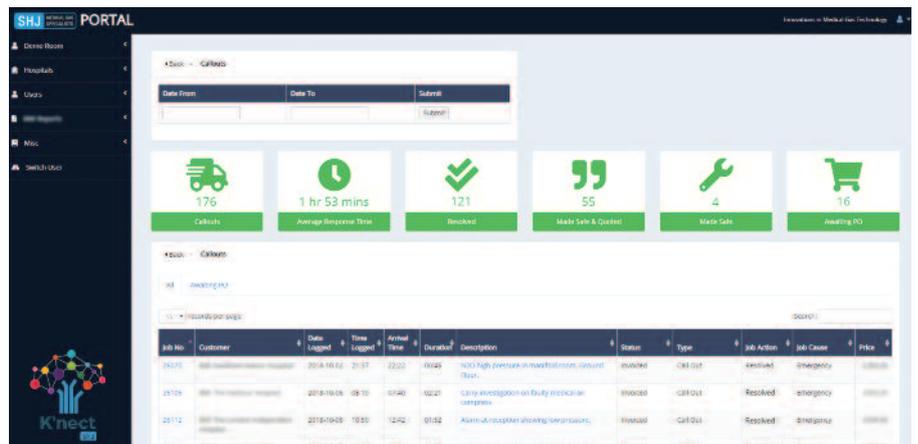
Stafford Scopes added: "We pride ourselves on doing quite a lot of our training 'in house'. Shaukat Ali, our Installation & Commissioning manager, is very knowledgeable on the many different types of alarm system, and runs training courses accordingly. We also send staff away for training. Shaukat has one current job where his team is installing 22 different alarm panels, and has taken both some of our experienced engineers and newer recruits with him to test and commission."

Useful familiarisation

James Forgan added: "That is a great way to get to understand how an alarm system works. If you understand the installation and commissioning, then if



A view of the main dashboard on the K'nect portal.



A variety of call-outs, the status of each, and average response time, shown via the K'nect portal.

you need to go back to basics when fault-finding, you have the appropriate knowledge. Some of the alarm systems can be complex, and you may be dealing with hundreds, if not thousands, of metres of cabling across a large acute hospital."

In addition to having a well-trained and capable workforce, SHJ is especially proud of its harnessing of 21st century communications technology to help customers get the best out of their medical gas systems. Stafford Scopes explained: "For example, Professor Luo is able to use AI and edge computing to 'talk' to the compressors in our medical gas systems in such a way that - for instance - he can gauge the temperature at which different parts are running, and the speed the motors are turning at, remotely. We have worked closely with HPC to exchange such data, which is provided via the Empower controller, which controls the air in the vacuum plant. Evolution is the complementary alarm and remote monitoring system. The newer Emanate is a more 'intelligent' version of Evolution; for instance, it will trend the compressor's temperature, and in future will be able to undertake vibration analysis, and listen to the acoustics in the plant room. Because we will know what the 'normal' running sound of the system is, Gaoyong will then, for instance, be

able to tell whether a belt is beginning to wear."

Refining both new and old

Professor Luo explained: "We are constantly evolving Emanate's capabilities, while simultaneously refining the Empower and Evolution systems. For instance, we previously used a PLC controller in Empower. While reliable, we believed we could improve its communication power to obtain data from the system's 'far side', allowing even more effective remote control and monitoring. We therefore replaced the PLCs with ARM processors - which offer considerably better processing power, and the ability to use AI, 5G, edge computing, and the IOT communication network - to link up the various components. A 5G module can thus be used much more effectively to send a signal from the 'far side' of the medical gas system to our server, allowing us to collect all the data we need."

The Professor continued: "Our new Emanate 'intelligent' plant monitoring and analysis system is based around edge computing, distributed 'cloud', and blockchain technology, to gather all the information, and record, analyse, and trend it. This helps us determine our future control strategy, and, based on the

condition monitoring data, to decide when the next service or maintenance needs undertaking – in other words, predictive maintenance. The aim is to make the system operation both more ‘intelligent’ and more efficient, and to be able to predict what faults are likely to occur and what interventions might be needed.”

Different manufacturers’ plant

James Forgan said: “A large acute hospital may well be running, say, three different air and vacuum plants from different manufacturers, and our alarm system will link in to all of them. We can also link Emanate to other manufacturers’ alarm monitoring and plant control systems.”

Professor Luo said: “Our single ARM PCB can act in both control and communication mode, enabling, say, a Trust’s Estates manager, to have excellent visibility and control of the condition of a number of different medical gas plants, via Evolution, at multiple sites. Currently, we believe Emanate is unique as a medical gas system monitoring, trending, and analysis tool. Another breakthrough is the ability to use the same PCB to talk to other companies’ alarm panels. The PCB is incorporated in the latest Evolution system, and in Emanate. In the future, in building up our IOT offering, and what is known as the ‘Industrial 4.0 revolution’,” the Professor added, “it’s likely that the PCB ARM processor will play a significant part.”

At this point, Shaukat Ali, SHJ’s Installation and Commissioning manager, introduced himself, and began telling me about his team’s role. He said: “We undertake medical gas pipework or laboratory gas installations, and can also install any type of air, vacuum, and AGSS plant. We can also fit gas detection systems. We have a large installation

order book currently. For example, at one leading London hospital we are installing medical gas systems for both a new ICU and a Neonatal Intensive Care Unit, while on the other side of the capital we are fitting a system in a new Endoscopy Unit, which we believe is a unique installation – in that we are providing two containerised plant rooms, one housing vacuum, and the other medical air plant. Effectively,” he explained, “we get large bespoke containers, and then install our medical gas plant inside them. The units are transported to the hospital, and if they need to be moved, the Trust’s Estates and Clinical teams can easily crane them into another location. These are permanent medical gas plant solutions for healthcare facilities, and tend to be a considerably cheaper option than building such a unit from scratch.”

Serving the NHS and the private sector

Giving a further flavour of some of SHJ’s current installation work, Shaukat Ali explained that his team is installing medical air, oxygen, and vacuum systems for a new A&E extension at ‘a prestigious Midlands hospital’, all the medical gases for a new Imaging Suite at another major London hospital, and providing new medical air, oxygen, and vacuum plant to two privately-owned clinics on Harley Street. He said: “Our installation engineers work in teams, and, depending on the job’s size, could be at a hospital for a year or more. Some of our most experienced installation engineers have been with us for 12-13 years. I joined as a Maintenance technician, aged 19, straight from college, after completing an HND in Electronic Engineering. I am now a Quality Controller on the national register of such personnel for medical gas.”

The final half-hour of our discussion

focused on SHJ’s K’nect customer portal. Stafford Scopes said: “We have constantly evolved the portal, and are always seeking to add new functionality. For instance, we are now allowing hospitals to add in even more compliance data on K’nect. We can include Permits to Work, record drawings, safety valve certificates, and all the other key information Trusts might need for compliance. All the data is encrypted, and thus only accessible to authorised users.”

Focus on core business activities

Matthew Sealy explained: “Our engineers use PDAs which ‘connect’ to our Service Management System, which holds all the key data on contracts, jobs, and scheduling. K’nect is linked to the Service Management System, and can thus ‘talk’ to our secure IOT network and all our industrial devices. We are putting information from multiple sources onto K’nect to provide compliance, uptime, and reliability data.”

Stafford Scopes said: “Our Service Management System and K’nect are based around an SQL database, to which all the engineers’ data feeds in. Matthew, and Software engineer, Barry Alleway, then extract whatever information they need. In contrast, our competitors tend to just scan information and reports into their databases – a more manual and complicated process, which can fall behind. Our goal is for customers to be able to upload all their own compliance data, potentially from multiple sources.” While with the existing SHJ portal, on-site hospital engineers have had access to only limited information on plant performance, such as PPM reports and documentation, Stafford Scopes explained that with the new controllers, they will be able to view significantly more detailed data.

A ‘constant health check’

Shaukat Ali said: “The AI technology enables us to keep a constant health check on medical gas plant. Until recently, the data that has come back has confirmed that the plant is running fine – via a number of green lights, and when it is temporarily ‘dead’ – via red ones. We can now, however, using the Empower intelligent plant controller and the Emanate monitoring and analysis system, give the plant a ‘health check’, which enables plant adjustments or remedial action before performance deteriorates. If, for example, the plant is getting too hot, our latest controllers will perhaps change the operation schedule by taking a compressor offline, simultaneously making us aware that there is a potential fault. The controllers will also identify characteristics such as pressures falling unexpectedly, or running faster rate than normal, and, if necessary, bring in



Pictured, left to right, at SHJ’s Chesham headquarters, are MD, Stafford Scopes, Financial controller, Michael Anthony, and Service manager, James Forgan.

compressors earlier.” The new K’nect portal will also now display all the service and training records of SHJ’s engineers, and comprehensive compliance information. In future, the aim is to provide more real-time data on plant performance.

Stafford Scopes added: “In making more data viewable, we have listened to our customers, taking account of their feedback on additional features they would like to see. The end-goal remains the same – to ensure that our customers’ medical gas systems run optimally, with maximum reliability, minimal downtime, and in a way that reduces energy consumption, and for any issues to be identified and addressed well before they impact on performance.”

Meeting KPIs

James Forgan said: “With many customers’ medical gas systems, we have to meet Key Performance Indicators. Having discussed with the customer its parameters at the outset, we can then set up the system to monitor records, attendance, and travel times. Every healthcare customer is different, and although NHS Trust estates and engineering teams all work to HTM 02-01, they often require different things. Some customers, for instance, only require Planned Preventative Maintenance, and not servicing. They will thus only be able to see, via K’nect, the maintenance work we have undertaken on their plant.”

Confidentiality of data

Confidentiality of data is a key consideration today, and Matthew Sealy explained that in holding and using customer data, SHJ abides by the principles of ‘Confidentiality’, ‘Availability’, and ‘Integrity’. He elaborated: “The ‘Confidentiality’ aspect means that we only allow access to the portal to specific people, while the ‘Integrity’ element relates to whether data has been changed



Business Systems manager, Matthew Sealy, has spearheaded the development of both the Enforce ‘intelligent’ plant control system, and the complementary Emanate Artificial Intelligence-driven data management and analysis software, alongside Professor Gaoyong Luo. The latter – a Professor of Communications at both Brunel University in the UK, and Guangzhou University in China – is an acknowledged expert in 21st century communications technology.

unjustifiably, or even potentially fraudulently, to try to ‘fool’ the customer. These principles apply not just to medical gases, but to all IT systems today. We have had early iterations of K’nect for 10 years, and the system is still evolving today. We have a ‘live’ version, and a list of desired features to add. It’s a constant development cycle. Another of our plans,” he explained, “is to link the Knowledge Base we are building up to K’nect.” Stafford Scopes said: “Currently, if one of our engineers changes the safety valves on a medical gas system, we will have it on record, but in future, should a Trust engineer want to change the valves, they will be able to upload that data to the portal. They will also be able to add details of staff training records, information on contractors (such as their membership of CHAS), insurance details, and unique tax references, and to incorporate a list of



personnel associated with particular plant, along with emergency and useful phone numbers, details of Operational Policy, quarterly test certificates, and records of QC visits. I think that as an agile, medium-sized British company, with field-leading IT expertise, we are some way ahead of our competitors here.”

Proving compliance

Here SHJ’s Operations director, Phil Hudson, a former NHS Trust Estates director, said, anecdotally: “When, as an Estates director, I met up with other Estates personnel, I was often asked: ‘What keeps you awake at night?’ I invariably answered ‘Proving compliance’. The first thing that happens when anything goes wrong is that everybody wants to see the records. It’s no good you simply having a feeling you are doing things right; you have to be able to prove it. It’s the same with visits from the CQC; when they descend on you, there is a tendency for everybody to panic and look for records, whereas if you have a system like K’nect, you simply log on and show the relevant personnel the appropriate data. You don’t have to worry about finding files somewhere on a shelf.” Matthew Sealy explained, as an interesting discussion concluded, that, to make access to K’nect as ‘universal’ as possible, SHJ is now developing iOS and Android ‘apps’, so that users do not need to use a web browser to view the portal.

All in all, my second visit to SHJ proved as interesting as the first; the medical gas specialist is clearly proud of how far it has come, and, as the day’s discussions had made clear, the pace of innovation at the Buckinghamshire-based firm shows no sign of slowing.



Operations director, Phil Hudson (left), is a former NHS Estates and Facilities director. Shaukat Ali (right), Installation and Commissioning manager, who originally joined the company as a Maintenance technician, aged 19, ‘straight from college’.

