

Boosting plant performance through the power of AI

Medical gas system solutions specialist, SHJ, believes many current hospital medical gas systems may be running inefficiently – potentially wasting energy, adding to electricity consumption, and increasing the likelihood of premature breakdown. As *HEJ*'s editor, Jonathan Baillie reports, with considerable IT expertise – including having on its team a leading world authority on 21st-century communication technology, and using AI, edge computing, and Internet of Things technology – the company is fast developing systems which will not only ensure such equipment's optimal running remotely, but will even detect small performance reductions before they become more serious, and could, in future, eliminate altogether the need for human intervention in such systems' running.

SHJ, which is today based in three modern business units in Chesham, was established in 1967 on another, smaller site in the Buckinghamshire town by Ronald Scopes, the father of the company's current owner and MD, Stafford Scopes. A former head of BOC UK Medical, Ronald Scopes established the business to address a sizeable backlog of hospital medical gas installations at the time; this was largely a result of BOC Medical offering to install such systems at no cost, with hospitals paying only for the gas supplied. Consequently, BOC found itself unable to meet demand for installations as quickly as the hospitals wanted. "On establishing the business," Stafford Scopes explained, "my father offered the hospitals a simple choice – pay him for a quick, efficient, and professional installation, and get it done straight away, or work with BOC and wait. Many hospitals were happy to pay, and SHJ's business quickly took off. The first order, worth £3,000, was from Hammersmith Hospital – which is still a customer today – and was sufficient to give my father the confidence to really get the business going."

A 'means to an end'

Stafford Scopes took over from his father as MD of the business, aged 27, in the late 1980s. He explained: "At that point the company was still very modest in size, but over the past three decades, particularly, we have expanded considerably, and now have a team of 38, 26 of whom are engineers 'out on the road' covering England, Scotland, and Wales."

While the first of SHJ's three units, Unit 4, houses administrative, finance, marketing, R&D, and customer service functions,



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the adjoining Unit 5 accommodates a well-equipped parts store and the company's sophisticated and powerful server. Kept behind a metal screen, the twin-rack server is securely linked to the NHS's N3 IT infrastructure, and holds what Stafford Scopes described to me – on



SHJ's owner and MD, Stafford Scopes.

a recent visit to SHJ – as 'a vast repository' of data on customers' medical gas systems. The medical gas specialist now has maintenance contracts with around 130 Trusts and private healthcare providers across England, Scotland, and Wales. A third building, just behind, houses a modern production facility, where SHJ manufactures medical air and medical vacuum plant, and assembles medical gas

pipeline components and other associated fittings for the systems it installs.

A reputation for service

Stafford Scopes said: "Over the years we have established an enviable reputation for the quality of our installations, the associated maintenance, and a fast, responsive call-out service, and some of our customers – such as London's Royal Brompton, Royal Marsden, and Hammersmith Hospitals, have been with us for over 50 years. We have won most of our work through word of mouth when, say, the Estates manager at a Trust or private hospital has recommended us to a counterpart elsewhere."

Although SHJ and its management team are proud of this legacy, and the company's long-standing relationships with many of the business's healthcare customers, Stafford Scopes' wife, Yingying Scopes, who is Company Secretary and head of Marketing, told me SHJ had spent much of the past 15 years 'striving to bring the medical gas sector into the 21st century' – by continuously developing and enhancing its online services offering.

Moving into the 21st century

She explained: "Having digitised all our accounting, customer service, and data management functions, we now collect and store on our server here a vast amount of data on our healthcare customers' medical gas systems and our associated work for them." One of the results of a drive to transition to a paperless office initiated a decade and a half ago was the development of SHJ's 'unique' Customer Portal, an easy-to-use 'front end' for customers wishing to access up-to-the-minute data on their medical gas systems, which is central to the company's and offering.

Accessible via a secure 'log in' on either a PC, or a portable device such as a mobile phone or 'tablet', and provided at no cost to all maintenance contract customers, the Customer Portal provides users such as, say, a senior healthcare engineer responsible for the smooth running of a Trust's medical gas system, with a comprehensive, up-to-the-minute picture of the operating and – if applicable – fault status of all the medical gas equipment on their site. Stafford Scopes said: "We've been extremely lucky, over the years, to be able to recruit some really able, expert IT personnel, with a passion for the field. For example, Matthew Sealey, who we took on about 20 years ago as a young man with some existing IT expertise, has really developed and built on his knowledge, both hands-on and via training, and his input in our systems development has been invaluable."

A knowledgeable and capable team

"Matthew, the SHJ MD continued, "originally supplied us with software, but on joining SHJ, worked as part of the team that developed the Customer Portal for us, alongside Professor Gaoyong Luo, a Professor of Communications both at Brunel University in the UK and at Guangzhou University in China. The Professor has been a real driving force behind the continuing development of our online and IT capabilities. Gaoyong is an acknowledged expert on 21st century communications technology, such as 5G, Internet-of-Things-enabled devices, edge computing, and AI. He not only played a big part in developing our original 'intelligent' plant control system, Empower, and the associated plant monitoring / alarm system, Evolution, but has also helped us continuously develop and improve the Customer Portal, which draws data from both systems. Over the past 5-10 years, he has been working on some really futuristic software innovation and R&D for us, based around 5G networks, machine-to-machine learning, and AI. Such technologies, and the vastly enhanced data analysis and management capabilities they provide, are at the heart of our two newest innovations – the Enforce intelligent plant control system, and the highly advanced AI-driven Emanate data management and analysis system."

Long-standing interest in IT

Stafford Scopes explained that he himself had a keen and informed interest in IT since his early days as a fitter with SHJ – he later went on to gain experience both as a service and compressor engineer – before later taking up the role of MD. He said "Medical gases has always been a fairly traditional mechanical discipline, but about 15 years ago, while Yingying and I were on holiday in France, we were suddenly struck by the fact that medical



Yingying Scopes with SHJ Contracts manager, Sigita Rackyte.

gases and advanced IT had never really had any major connection. This realisation of what we believed was a missed opportunity heralded a concerted drive into harnessing IT as part of our offering. This has continued to this day, and is at the heart of our new product development strategy."

Fierce competition

Yingying Scopes expanded: "Back in the early 2000s we were already well-established in medical gas systems, but competition was getting fierce, and price-cutting was rife. We felt we needed a key differentiator. We initially promoted the fact that we provided the best installation and after-sales service, but we were by no means the cheapest, and the NHS always has one eye on costs. We therefore decided that enhancing our offer using IT to make a wealth of machine data accessible to customers online would be a good way to add value."

Here, Phil Hudson, SHJ's Operations manager, a former NHS Estates director who joined the company six years ago from Imperial College Healthcare NHS Trust, and has since contributed considerable expertise and knowledge both in building services engineering and NHS estates and facilities practice, said: "With the volume of now work going through, SHJ recognised that it needed to transition from an entirely paper-based records system to a digital one." Key, he explained, was the implementation of an Enterprise Resource Planning system, to coordinate all the job, stores, and labour management. Before this, however, with the input of Matthew Sealey and Professor Luo, SHJ had developed and launched its first 'intelligent' plant control system, Empower, which provides fully automated plant control, and the complementary 'real-time' 24/7 Evolution 'intelligent' plant monitoring system. The latter gives users real-time information about their gas supply system, 'guiding them to any fault', and, as SHJ puts it, 'reducing response time, and manipulating the process and system components in an easy, intuitive manner'. Evolution is available over 'cloud' services, and can be streamed to remote devices.

Data fed into the portal

Stafford Scopes explained: "Once the Customer Portal had been developed, the data gathered from both Empower and Evolution was fed into it, as indeed it will be from our new systems – the Enforce intelligent plant control system, and the Emanate AI-driven data management and analysis software. This data is then available both to customers and to us to view and use to improve plant performance, reduce energy consumption, and pre-empt problems."

"The big difference with Enforce and Emanate, however," he continued, "will be that the data will be far more comprehensive, with the algorithms incorporated in the Enforce system geared toward cutting energy consumption. Emanate, meanwhile, is a really advanced software system that captures data and uses AI to make fast, reliable decisions autonomously through Enforce and Evolution to maintain optimal medical gas system operation. Importantly, the algorithms built into Emanate will also detect – at an early stage – when plant is running sub-optimally, or, for example that components need replacing, or oil levels are low, and take corrective action, in many cases without the need for human intervention."

"We were extremely lucky," the SHJ managing director continued, "to be able to recruit Professor Luo. Having first come across him through Yingying, he was over in the UK from China one Christmas, and began working with us to develop a controller. The result was our first such unit, the Empower, which, along with the



SHJ says Professor Gaoyong Luo – who has served as Field Chair of Electronics Information and Communication Engineering at Guangzhou University in China, and is an expert on AI, IoT technology, and edge computing – has been 'a real driving force' behind the continuing development of its online and IT capabilities.



Stafford Scopes on the SHJ stand at last month's Healthcare Estates 2019 event.

Evolution plant monitoring system, is now extensively used by the hospitals we serve. Having joined SHJ about a 12 years ago, Gaoyong left the business for a while once Empower and Evolution had been launched, to focus on family matters and his academic/teaching work. He returned to SHJ, however, in January this year, which significantly boosted our IT expertise, and we have since invested significantly in R&D to enable us to develop and fine-tune the Enforce and Emanate systems, both of which we believe are genuinely ground-breaking, and like nothing else on the market currently."

Real-time diagnostic reports

SHJ says its 'next generation' intelligent plant control system, Enforce, is designed to provide real-time diagnostic alerts and fault logging from a medical gas system to a PC and over 'the cloud', 'ensuring that the system is providing maximum efficiency, accuracy, and economic benefits'. Stafford Scopes said: "Enforce is a comprehensive, easy-to-use, and fully automated system, which allows plant control from anywhere with Internet access for hand-held devices. We have already achieved energy savings of over 30 per cent on the running of the medical air compressors at Hammersmith Hospital through the combined use of Evolution and Empower there, and with Enforce, which will run energy-saving machine learning algorithms across its plant control, the potential savings could be even higher."

With increasing use of AI, the anticipated roll-out of 5G in the UK, and greater proliferation of IoT-connected devices, SHJ anticipates even greater scope to exploit Enforce and Emanate's capabilities in the future. Stafford Scopes said: "Once 5G is widely available, the lightning-fast data transfer speeds on offer should allow really rapid data transfer not only from the Empower or Evolution controllers at hospital sites to our server, but also from the server to a range of

portable devices held by users. Emanate, meanwhile, will use 21st century communications infrastructure - wired or wireless - to harness plant running data and then, via Artificial Intelligence, to make fast, reliable decisions through Enforce and Evolution to ensure that the connected medical gas system is running optimally, and also that any potential issues are detected early, and can be addressed before they have a serious impact."

Autonomous operation

In the not too distant future, SHJ explains, the medical gas systems of a Trust or private healthcare provider at several different sites could be run 'almost completely autonomously', with the reassurance that should a fault occur, or say, a compressor or medical air dryer begin operating sub-optimally, the system will identify the issue, and adjust the parameters to restore normal operation, or, in the event of a complete failure, flag it up to, say, a healthcare engineer in the hospital's Estates office, via the Customer Portal.

Stafford Scopes described Enforce as a 'Mk 2 version' of the original Empower plant control system, with 'considerably more intelligence and even greater energy-saving potential', and Emanate as a 'natural progression' of the earlier Evolution plant monitoring system. Last month at Healthcare Estates 2019 SHJ was able to tell visitors about the advanced capabilities of both systems. While Emanate will calculate, manage, and analyse considerably more data than any SHJ system to date, users of the system - as they do if running Evolution currently - will still access all the data via SHJ's Customer Portal, which is now in its second iteration. The portal lists every item of medical gas equipment that SHJ services for the user organisation. Phil Hudson said: "From my experience working in NHS estates and facilities departments, I know that maintaining accurate plant servicing and maintenance

records, as well as asset management, can be time-consuming and challenging, especially at a large hospital or a multi-site Trust. The Customer Portal is a one-stop-shop that provides healthcare engineers with all the data they could possibly need on their medical gas system - from details of the manufacturer, the model, installation, all servicing and maintenance records, engineer visits, and the outcome, and when various components will reach their end of life, to future inspection dates. It will also hold all the certificates that prove that regular maintenance has been undertaken."

A free issue

Provided free to any SHJ customer with a maintenance contract, the Customer Portal links directly to the SHJ server, on which all the data is securely held. Information on the status on of all plant is easily visible from the front screen, with a RAG (Red, Amber, Green) system used within the panel relating to particular plant operating criteria. Provided the main green alarm panel remains green, the user can be sure that all medical gas systems are operating within set parameters. Should this change - or, for instance, a fault or gas leak occur, the relevant panel will illuminate amber to signal an alarm and need for attention, and red in the event of failure. Information from the existing Evolution plant monitoring/alarm system can be seen at a glance via the portal both on a computer or handheld device, while for healthcare customers paying for this service, text alerts can be sent both to users, such as hospital estates personnel, and to SHJ, as and when needed.

Every aspect scrutinised

Stafford Scopes said: "With regulators like the CQC increasingly scrutinising every aspect of a hospital's activities, including plant maintenance, a healthcare engineer can, at short notice, view and print out a detailed historical record of the operation and maintenance of a particular medical gas system or individual machine in response to pretty well any question an inspector could throw at them." In addition to the data already discussed, users can bring up and view detailed records of any breakdowns and how and when they were resolved, as well as how long the engineer was on site. Stafford Scopes explained: "Many hospitals must meet Key Performance Indicator, or KPI, targets, and indeed a number impose KPIs on us as part of the original tender - for example stipulating that in the event of a compressor breakdown, a gas leak, or another 'event' that could jeopardise patient safety, we must have an engineer on site within four hours."

While the current pulling together of key operating data from the Evolution

controllers at hospital sites already provides users with a wealth of information – for example Stafford Scopes showed me, viewing an actual ‘live’ hospital system, the voltage that a number of compressors were running at – with the launch of Enforce and Emanate, considerably more data will be both viewable and available for analysis by the Emanate system to maintain, and, where necessary, adjust, system performance. For example, should the software detect that parameters such as dew point, voltage, air compression, or oil temperature, are outside set limits, the AI-driven software will automatically enable adjustment through the nearest Evolution or Enforce controller to the plant concerned to return it to optimal operation. Where an engineer’s visit is required, this will be signalled via an alarm within the Customer Portal.

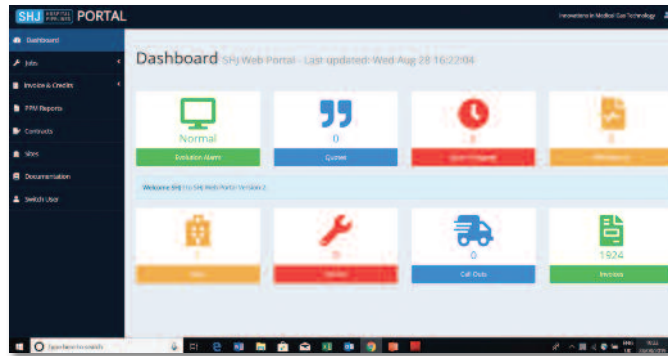
Ability to ‘drill down’

Stafford Scopes explained: “The user can drill down, for example, into any of the gases, and view all the fault condition panels to be sure that there are no issues, as well as looking at, say, how a series of four compressors are running. We can trend alarms and faults with certain plant; a repeated call-out may suggest that a particular component needs looking at or replacing. Alternatively, if a hospital typically uses a cylinder of Nitrous oxide every five days, and the system identifies a change to one cylinder per day, our trending analysis will quickly highlight that, for instance, there may be a leak.”

The SHJ MD added: “The Customer Portal also houses all PPM reports, with all records of work incorporating a digital signature from the AP. Despite the comprehensive data available,” Stafford Scopes stressed, “the portal was designed from the outset to be extremely user-friendly. If you wish to look at an individual component, it will tell you which plant room it is in, the manufacturer, what type of machine it is, the model, and who owns it.

Portal in third iteration

“We have had the Customer Portal for about the past five years,” Stafford Scopes continued, “and have enhanced it continuously, and made it more ‘feature-rich’, based on user feedback and our own ideas and innovations. It will really come into its own with the very substantial additional data gathering and analysis capabilities of Emanate. The day when a healthcare estates team will be able to set up a medical gas system and just leave the equipment to run, with just the occasional onsite check and the remainder of its



A screen image from SHJ’s online Customer Portal.

operation run remotely, are close.” Aware that where a Trust or private healthcare provider requires it, SHJ will already take on monitoring their medical gas system utilising data from the portal, I wondered whether, with the enhanced data capture and analysis of Emanate, the company envisaged taking on more such work. Stafford Scopes said: “We can certainly do this if required, but the real goal is to be able to spot trends using AI, to get medical gas systems to talk to each other, as well as to us, and, in turn, to enable both we and the user to identify when equipment is not running optimally long before it causes a real problem. The advanced algorithms built into Emanate will – as we say in our product brochure – ‘allow for a rapid pre-emptive response to any imminent plant faults or failures with the implementation of best predictive maintenance planning and scheduling practices’.

A human analogy

He added: “To use a human analogy, by viewing the relevant screens via the portal, based on data drawn from Evolution, a healthcare engineer or estates manager will be able to see if, say, a compressor or air dryer is ‘dead’, but with Enforce and Emanate they will be able to detect as soon as it is ‘unwell’, and then either call a doctor, or ‘treat’ it automatically.”

Professor Luo explained: “We set out to develop the new AI-based systems in response to the growing development of computer networks for data communication. Once we have all the data that, for example, Emanate can provide on

our server, we should be able to do a great deal with it; our aim is to develop the AI algorithms to process very extensive datasets, allowing us to manage and utilise that data much more effectively, and in turn to help our healthcare customers optimise their plant operation, reduce their energy costs and time spent on maintenance, and have predictive information they can rely on.”

Stafford Scopes added:

We are keen to be seen not just as a seller and maintainer of hospital medical gas systems, but rather as offering a complete package of equipment, hardware, and software, that will ensure trouble-free, efficient, and cost-effective running of such equipment, and can also adapt to changing use and demand.”

Working with a London hospital

To prove the capabilities of its latest technologies, SHJ has recently installed the new Enforce plant control system and Emanate data capture software at a London hospital, following what Professor Luo described as ‘weeks of work to build up the SHJ server accordingly’. “We are also,” Stafford Scopes added, “initiating work with the UK distributor of our German-built Kaiser medical air compressors, HPC, to collect medical gas system data from 130 different hospitals. From this we should be able to identify common equipment failures and some of the main causes. HPC is keen to collaborate with us, and we are also looking at a Knowledge Transfer Partnership with Bedfordshire University. Working with its students, and with some of Gaoyong’s students at Guangzhou University, we hope to share this Big Data with them and ask them to analyse it, to help us devise more efficient ways of working. In future, armed with such data, we could, for example, analyse and compare the medical gas system operation at two similar 500-bed acute hospitals, and then look to address any inefficiencies.

“I am not aware of any other medical gas system specialist that has undertaken such advanced AI and IoT-based system development. Some of Gaoyong’s work is field-leading, and indeed there is no reason why the technology could not be harnessed by a number of other sectors, such as food processing, that use industrial gases, to enhance the efficiency of their operations too.”



Many SHJ medical gas systems sold today will incorporate German-built Kaiser medical air compressors.

■ Professor Gaoyong Luo and Stafford Scopes of SHJ jointly presented at last month’s Healthcare Estates 2019 event on ‘Power saving in medical compressed air systems by using real-time Artificial Intelligence’.