

A MAGAZINE  
FOR EMPLOYEES

WINTER 2012/13

# REVIEW

## COVER STORY

**Surfin' gas**  
Heatric is booming

### PLUS

**Learning to see**  
Allahverdi spearheads  
group-wide production system

**Soldier safety**  
Meggitt gets up close  
and personal

**MAAP on the map**  
Model factory doubles  
Singapore capacity

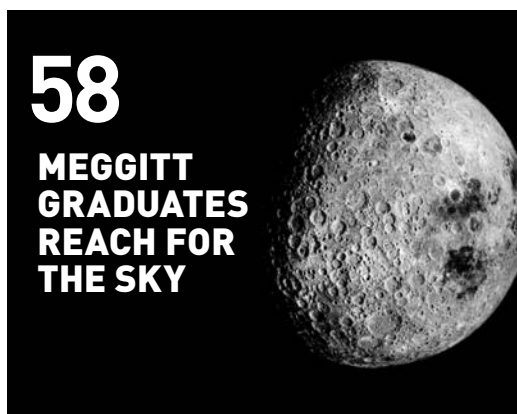
**Growing next generation talent**  
Our graduate recruitment  
drive is working

**20:20 vision**  
Jackson plans tech  
development 20 years ahead



# MEGGITT

- 1 Continuing on our journey**  
Our Chief Executive on next steps in the pursuit of excellence
- 2 Learning to see**  
Amir Allahverdi, Meggitt's new Group Operations Director, on how a group-wide production system will deliver sustainable improvements to quality and on-time delivery
- 20 FACTORY FOCUS**  
**Surfin' gas**  
The outlook for Heatric, a key player in Meggitt's growing energy business, just keeps getting better
- 34 Delivering dividends for decades**  
Top contract wins from 2012
- 36 MAAP on the map**  
With airlines based on Asia continuing to expand rapidly, Meggitt has doubled capacity with a new model factory
- 42 Wanted: Bright ideas to boost Meggitt's future**  
Meet Keith Jackson, Meggitt's new Group Technology Director
- 45 "Wellness" pilot launches in the US**  
Meggitt sponsors points-mean-prizes employee health and fitness programme
- 46 Smart engineering saves lives**  
How Meggitt products protect our armed forces



- 52 THE GRADUATES**
- 52 Bright prospects are the best recruiting sergeant**  
Why they are joining
- 54 Graduates meet gurus**  
Great minds exist beyond the campus
- 58 Graduates reach for the sky**  
Spotlight on career success for existing recruits
- 61 Bookmark our story**  
The latest on our publications, on-line and in print

Inside





# Securaplane first to pilot change

Having completed its readiness assessment in November, Securaplane will roll out the Meggitt Production System in the first week of February 2013.

**THE COMPANY IS A NEAR-IDEAL PILOT SITE**, says Securaplane's President Shubhayu Chakraborty: "We are Meggitt in microcosm: a compact business, on a single site, but with every process present. We can deploy and test everything that the Meggitt Production System has to offer, right here."

Securaplane is also culturally well-prepared. "We started our own 'Lean conversion' three years ago. We already have strong employee engagement with continuous improvement, and everyone is comfortable with the concepts, practices and 'lingo'. We don't need a huge sales pitch to get people fired up. We can get into deployment right away."

Lean has already been good to Securaplane—big improvements in delivery, quality and inventory—but it has also revealed the limits of going it alone. "The Meggitt Production System will unlock so much more in the way of resources and ideas, giving us access to best practice backed by excellent training materials—all of which we have helped to develop. Meggitt group support means we can do everything so much faster and better. The Meggitt Production

Lean has already been good to Securaplane—big improvements in delivery, quality and inventory—but it has also revealed the limits of going it alone. The Meggitt Production System will unlock so much more in the way of resources and ideas

everyone understands their own commitment to the work process, and takes responsibility for delivering it. DLA also provides an efficient and transparent path to escalate issues, ensuring they are solved quickly and completely at the right level.

There's great emphasis on what's called 'visual management' or the 'Gemba walk'; managers going to where the work is being done to see for themselves what's going on. Chakraborty: "On the shop floor, for example, a production cell will know its output on an hourly basis, how that relates to plan and what obstacles are causing any shortfall. Cells report to 'focus factory managers' who visit regularly and can see quickly if a cell has a problem it can't solve for itself. The focus factory manager is then responsible for doing whatever's needed to solve that problem."

The hour-by-hour work of production cells—Securaplane has ten, operating in flow, not batch, for reasons of efficiency and quality—is governed by the organisation and cleanliness framework known as 6S (Sort, Set in order, Shine, Standardise, Sustain, Safety). 6S increases cell efficiency and facilitates visual

## This is a well-made programme. If you embrace this system and learn from it, the results will follow

System is now essential to Securaplane's drive for competitive advantage through higher performance," says Chakraborty.

Vince Bartuccio, Securaplane's Continuous Improvement Leader, previously site leader for continuous improvement at Bombardier's service centre in Tucson, speaks from experience: "This is a well-made programme. If you embrace this system and learn from it, the results will follow."

For all Securaplane's continuous improvement experience, extensive preparations for roll-out have emphasised maximising staff awareness just the same: "We've been running lots of communications and training activity—all-hands meetings, electronic presentations on the shop floor, update sessions with the senior team—explaining how performance is managed in a Lean environment, looking at the training matrices, and putting people through our concentrated immersion programme on the concepts and culture of Lean."

Securaplane has been helping trial and refine Meggitt Production System specifics for months now. "Our shop floor people have closely evaluated the daily layered accountability, the 6S framework and the principles of 'visual management' that are at the heart of the MPS," explains Bartuccio. "Before that, multi-functional teams worked through the new training modules, helping to finalise the detail."

Daily layered accountability (DLA) is the name given to the nested structure of responsibility and accountability in which

management by bringing structure and discipline to the 'what, where, when and how?' of materials and tools storage and use. "It's really a way of life for the cells," says Bartuccio. "If you live 6S at home, your garage never looks like a tip and you can always find your car keys!"

Securaplane already runs a programme of regular kaizens: two a month, very focused, lasting three or four days. They always include senior leadership (emphasising the importance of the process), as well as representatives from across the functions to recruit fresh perspectives and help spread the cultural aspects of continuous improvement throughout the organisation. Chakraborty: "Under the Meggitt Production System, our kaizens will be much more shop-floor orientated, looking at standard work geared mostly to improving productivity—though also quality and delivery—and aimed at continually improving the match between our production cycle time and customer demand."

The Securaplane team is now putting the finishing touches to their roll-out plan for February. Employees will notice the Meggitt Production System difference immediately, says Chakraborty: "We are kicking off with multiple simultaneous kaizens involving one-third of the company." He acknowledges the impact on results will take longer to feed through, as competitiveness benefits accumulate steadily. "That's OK," he says. "This isn't a sprint, it's a marathon."



Amir Allahverdi

# Louis Chavez

Ian McMurray

Bernie Stevens

Martin Calland



Louis Chavez with a ballistically-resistant, crashworthy fuel tank at Meggitt's Rockmart plant, Georgia, USA

**C**havez is one of nature's systems thinkers. Even as a kid in Albuquerque he was pulling stuff apart just to see how it worked. Today, he's not much changed, as anyone will know who's seen him at work on the factory floor—questioning, probing, hoovering up information and insights. Over a 35-year career, his expert knowledge of what it takes to build a business operating system, and then to make it work, has been hard-won and hands-on. It has been developed in numerous operational roles, from engineer to site general manager, via product management, engineering design and development, operations leadership, and sales and marketing. But he's still that same enquiring enthusiast who, way back in the late 1990s, first grasped the enormous operational significance of the relationship between engineering and production as general manager (GM) of Honeywell's military avionics division.

"As an engineer I had no awareness of how the things I was doing, or not doing, had an impact on the factory. We'd design something for a Boeing or a Lockheed, help get it operational in the engineering lab and on a few test planes, then move straight on to the next thing." As a project manager he began to see the bigger picture, but it was later, as a newly-promoted GM, that it really clicked: "Being able to produce the best technology in the world doesn't much matter if you can't manufacture it to the required quality, get it to the customer on time, and then do that day after day." In other words, islands of excellence are not

**WHISPER IT: LOUIS CHAVEZ IS A REVOLUTIONARY.**

The man leading the design and introduction of the new Meggitt Production System (MPS) plans to turn Meggitt upside down and he doesn't care who knows it.

"Everyone understands what the old organisational pyramid is saying," says the new Director of Meggitt Production Systems. "Directors at the apex and shop floor at the base, as if everything exists to support the work of the boardroom. But it's really up the wrong way." Explain? "Gemba". In the parlance of continuous improvement, this Japanese word means 'the place where the work is done' or 'where the value is created'. Turn the pyramid upside down and you re-locate the centre of Meggitt's universe to the point where things are actually being made—the shop floor.

"That's why we've been travelling to production sites all over Meggitt on

**I'm a 'small government' kinda guy. I'm here to work in partnership with the divisions and their production sites—to build their capacity and capability, not mine. My office is their shop floor and that's the way I like it**

our 'deep dive' visits (see box: **Diving Deep, page 14**). It's why we don't sit in a conference room when we get there, but get out on the factory floor to listen, learn and understand. That's our revolution. Business operating systems like the Meggitt Production System are the best way we know to refocus a whole company onto what it takes to make great products exceptionally well; getting them 100% correct and delivered on time, day in, day out."

the answer to continuous improvement. It's about treating the business as a single system, because it's systemic excellence that wins the big prizes.

Picture a single creature, hungry and looking for food, but doing so with 47 separate nervous systems each controlling a different organ or limb. It's hard to imagine the evolutionary question to which such an ill-designed creature could ever be the answer. Not so hard to imagine it's long-term survival prospects though. In →



## What's in a name?

Louis Chavez and his colleagues are keen to defuse any misunderstandings about what the term Meggitt Production System means.

IT SEEMS SOME FOLKS THINK THE TERM 'PRODUCTION' is a synonym for 'factory floor'. But it really means pretty much everything that happens on a production site. In other words, everybody working on a production site is working in 'production', from sales to shipping," says Chavez. "So, how does order entry, or finance, or compliance affect production? Half of all production issues are not found amongst the machines and materials. Bad or confused sales and order entry flows can cause chaos. If the shopfloor doesn't know what's being promised to the customer or can't rely on what they are told about it, how can they plan and organise? As for functions like finance and compliance, what good is it for the shopfloor to run sweetly only for output to pile up at the factory gate because a credit stop has been placed on the customer or the export licences aren't in place?"

This is what you might call 'joined up manufacture' and it's why one of the most important innovations introduced by the Meggitt Production System will be the site leadership councils. Chavez: "These are the bedrock of this new culture of functional collaboration. They bring together representatives of all site functions so that operations are led in a properly integrated, joined-up and collaborative way—and always with the experience of the customer in mind."

Lean as in evolution, anything which doesn't 'add value' is targeted for eradication. Start to think of Meggitt as a single organism and all its duplication soon looks like simple wastefulness too; an evolutionary hangover crying out for something to reorganise it and recycle it into competitive advantage. That 'something' is the Meggitt Production System. Which is why, despite its name, it is so much more than a way

Between 2007 and 2011 Chavez led the development and global implementation of the Honeywell Operating System for its \$12 billion aerospace business, having first helped transform the company's deep affinity for 6Sigma (see box opposite: **Unintended consequences**). So how different will life be in the lean new world of the Meggitt Production System? "Someone working on

chain of creating customer satisfaction, not just the factory floor, can be at their very best. If we don't achieve that, then we are not going to get the best out of the system."

Lean environments require a different kind of leadership too. "When I ask site leaders how much time they spend on the shop floor, they very often say 'five per cent, maybe ten'. And when I say 'tomorrow it will be 50' they think I'm crazy. Here's the thing about Lean: everyone, at every level, is expected to take ownership and accountability for their roles. So you don't 'manage' people so much as help them get the best from themselves. You lead by example and by actively engaging with them—questioning, probing, prompting, exploring—to help them find their own way with things. The best answers are often tucked away inside the head of the person who lives the problem every day, but frequently they either don't know it or someone is not listening to them. So it's a Lean leader's job to help them release the power of what they've really got up there."

At this point, Chavez typically finds his audience wanting to ask the same question: 'how will I find the time to do my real work?' "I flip that and say 'this is your real work now, and doing it will free up the time you need by eliminating hundreds of hours of ad hoc meetings and waste.'" Within an operating system leaders get a tremendous amount of their information on the shop floor by working through a structure of 'daily layered accountability'. "It's these new structured accountabilities which really up-end the old pyramid," says Chavez with a certain glee. The details vary from plant to plant but, broadly speaking, daily layered accountability means organising work—and the visualisation and communication of aspects, into a structure of 'nested' production 'cells'. Day-to-day power and responsibility is devolved but importantly the exercise of that power and responsibility is also made more transparent and inclusive. Each cell (five or so people) meets first thing every morning for 10 minutes. They go over what happened yesterday—did we do the plan, where there gaps, what's being done about them, who owns the actions, what help do we need, if any—what's expected today and what's due tomorrow? Cell leaders then report to their module leader (escalating anything the cell can't solve for itself). Module leaders go on to meet value stream leader, before they, in turn, meet the site leaders. All along the way, leaders visibly document 'out of standard' conditions. By 9.30 a.m., the plant

## Someone working on the shop floor will feel a lot more control over what they do. They will see a lot more transparency in the way the plant is run

to refocus and energise the Meggitt shopfloor. It is a single, efficient, coherent system for running every aspect of Meggitt 'production'; and that means not just the machinery, materials and making, but everything a site does—from sales and marketing to delivery of the finished goods—wherever it is located. (See above: **What's in a name?—the meaning of MPS.**)

the shop floor will feel a lot more control over what they do. They will see a lot more transparency in the way the plant is run. And they'll have a much stronger sense that they are adding value and making a difference, celebrating wins along the way. We are doing everything we can to create an environment which is the kind of place where every person involved in that long

leadership knows exactly what happened yesterday right across the operation, who is working to close the performance gap, when it will be done and what help might they need. They can start prioritising straight away. "Which is what I mean when I say Lean production leadership is done on the shop floor, not in the conference room," adds Chavez. "As organisational capability matures, 90 per cent of challenges will be resolved at that layer one level."

Of course some of this will be unfamiliar at first, but none of it is alien knowledge. There are already many examples of it working at some level almost everywhere in Meggitt. "Look at Meggitt Polymers & Composites, Oregon. Their daily cell leadership meetings are sharp and focused." Chavez snaps his fingers for emphasis. "And they've done a great job with talent too, developing what they call an 'X-team' of junior leaders—the next generation—who run the site 'day by the hour'."

It's a common criticism of management 'systems' that they are rigid, bureaucratic and disempowering. Doesn't the emphasis on daily layered accountability and standard work carry similar risks? "No. Firstly, at the very heart of the lean philosophy and the operation of the Meggitt Production System is the fundamental principle that a piece of everybody's job each day is to improve what they did the day before. There's nothing disempowering about taking responsibility for growing yourself and your contribution.

And then, remember Pareto and his 80/20 rule? It's the 20 per cent of key processes we are standardising and which will produce 80 per cent of the impact we need. That leaves everything else flexible to accommodate differences in businesses, markets, people, processes. Building composites, say, will never be the same thing as building electronics, so you must have that flexibility."

As for concerns about the dangers of a bureaucratic tendency, they make Chavez chuckle. "You are talking to the guy who is responsible for something called a 'project management office' but who doesn't even have a desk, never mind an office to put it in. That's OK though. I'm a 'small government' kinda guy. I'm here to work in partnership with the divisions and their production sites—to build their capacity and capability, not mine. My office is their shop floor and that's the way I like it." •

## Unintended consequences

A striking feature of the Meggitt Production System—which may surprise some, but should please most—is that it does not come weighed down by a complicated array of special tools and techniques.

**IT'S BECOME A COMMON MISTAKE TO CONFLATE CONTINUOUS IMPROVEMENT WITH STATISTICAL METHODS**, says Meggitt Production System leader Louis Chavez. "It was probably the runaway success of 6Sigma (6S) in the 1990s which created the misunderstanding. 6S-type approaches are notoriously tool heavy and have a great need for expert practitioners. But that emphasis on tools almost inevitably became an overemphasis, and soon the tail was wagging the dog."

For nearly three years Chavez was VP of 6Sigma at Honeywell's \$3 billion Speciality Materials business in New Jersey. However, steeped though he is in 6S, he believes it led companies down a path not originally intended either by their business leadership or the original inventors. The 6Sigma business management strategy was developed by Motorola in 1986 and made famous by General Electric a decade later. What happened next, says Chavez, was a classic story of unintended consequences. "Spectacular early wins saw 6S teams of maybe 50 people grow quickly into many hundreds of dedicated full-timers. The wider business came to see 6S people as the only ones responsible for, and able to do, any continuous improvement or problem solving activity. Now tools experts were running the show; tool-driven 'fixes' had complete ascendancy over understanding the needs of the business system and

## Nowadays the most capable 6S professionals are combining their tools skills with a commitment to co-development

building organisational capability. Any thought of tearing the whole thing down and trying to replace it with something more rounded and people-focused was greeted as, well, heresy."

Chavez illustrates the problem with a nice analogy involving city architects and carpenters: "You want to build a city, but all you've got is expert carpenters with 25 different kinds of hammer. You end up with all these people running around with hammers—beautiful hammers—looking for nails to pound. What you don't end up with is much of a functional city. To build your city, sure you need people who are great with various kinds of tool, but first you need a city architect to create the understanding of how the city will work as a system and sets of standards to ensure common understanding: how all those bits fit together; how they complement each other; how they work together, and stay together."

Of course, the converse is also true. If all you've got is architects ...

**THAT WAS THE SECOND UNINTENDED CONSEQUENCE**, he explains. "We started to create our own version of an operating system, and soon the pendulum had swung too far the other way. Now tools were being under-used because folks were blaming 6S for the system-level problems, rather than seeing them as just an unintended consequence of having too much of a good thing. Getting the balance right between tools and systems, fixes and capability building, that took some time."

Meggitt's own extensive in-house 6S expertise is a real blessing for the Meggitt Production System, believes Chavez. "We are very fortunate to have so much 6S expertise at Meggitt already. It could save as much as three to five years of Meggitt Production System development time. Nowadays the most capable 6S professionals are combining their tools skills with a commitment to co-development, capability building and the empowering of others to be a part of continuous improvement. And that's exactly the role 6S will now play at Meggitt: as a problem solver, enabler and capability builder."

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 Amir Allahverdi

Louis Chavez

**Ian McMurray**

Bernie Stevens

 Martin Calland
 

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The market is reshaping our business, it wants a much higher level of commitment to quality, timeliness and cost control than much of the aerospace industry has been used to

**I'VE SEEN IT ALL—THE GOOD, THE BAD AND THE UGLY**, says Ian McMurray, Meggitt's new Group Quality Director. He brings a lifetime of experience in production quality management to his new role. "I've spent all my working life in an operational environment—various levels, industries, organisations—much of the time with formal responsibility for quality.

McMurray's first managerial responsibility for quality was in 1996 at Turner, designing and executing an improvement strategy for the assembly and test plants. This was also the year Caterpillar bought Turner and introduced him to advanced quality product planning, grounding him in quality systems, techniques and tools which many in aerospace still find unfamiliar. From Caterpillar he joined Smiths Aerospace in 2001, taking responsibility for its 80-strong assembly and test operation. Joining Meggitt in 2006, he became the business unit manager responsible for helicopter ice protection composites (amongst other things), before a stint as VP of operational

excellence for the Meggitt Equipment Group immersed him in the daily quality challenges faced by divisions. Most recently, he was group head of operations and quality.

For McMurray the pursuit of quality in everything Meggitt does is the beating heart of operational excellence. "There's only one thing driving our quality standards these days," he says, "and that is our customers. It is they who set the standards we must meet to remain competitive."

The so-called 'good old days'—programmes lavishly funded by governments, cost-plus pricing and enormous margins of error—are over, he says bluntly. "The market is reshaping our business, our organisation and our thinking simply by being so demanding about what it wants from us. And what it wants is a much higher level of commitment to quality, timeliness and cost control than much of the aerospace industry has been used to. If this is the modern commercial reality of aerospace, then the right response is to have excellent process capability right from the off, and

that means a rigorous Quality Management System as part of a single, integrated Meggitt Production System."

**H**e is wary of appearing a little too prescriptive, a little too top-down, but has been laying the foundations and raising the superstructure of the Meggitt QMS over the last two years working very closely with his divisional colleagues: "We could easily have written a manual full of 'thou shalt's' and 'thou shalt not's', but we already have one of those. In fact we have 47 of them—all different! Meggitt doesn't need checklists and tick-boxes. It needs a way to create a consistent, cross-functional, group-wide focus on improving the factors that do most to define Meggitt's performance in quality."

'Focus' is the operative word. "You can't create something like this at a stroke. You get there by degrees: making improvements where they are most needed and where they'll make the biggest impact." The approach he describes is based on the celebrated 80/20 principle. In 1906,



economist and mathematician Vilfredo Pareto noticed that 80% of outcomes (including the peas from his vegetable garden) often follow from just 20% of causes (one in five pea pods). In quality circles this gave rise to the idea of the 'vital few' or that small number of factors which generate the vast majority of quality 'escapes' (as errors and faults are known in the trade).

## The vital few

### McMURRAY'S QUALITY IMPERATIVES

- Tackle the root cause of escapes, not the symptom. A single set of structured codes help to label, categorise and track every escape, symptom and ultimate cause. Because all escapes are not of the same importance—admin versus airworthiness, say—they are also monitored and sifted for probability and likely impact. Specialist management teams, corrective action boards (CABs), track every escape, symptom and ultimate cause to ensure the corrective actions are the right ones and permanent.
- Understand the real probability and impact of an escape and then systematically minimise it. In quality terms, risk management means understanding and managing all potential adverse events, throughout production, including design, delivery, product and process.
- Eliminate escapes introduced by nothing more than moving things about. It is said that change is the biggest enemy of quality. Move something from place to place—one supplier to another, one Meggitt factory to another, between machining centres—and you always create a new escape risk which must be managed.
- Embed and optimise formal quality management thinking into new product launches from the very start, sustained throughout the life cycle, capturing all risks and sources of variation.
- Take a closed-loop approach, weaving quality planning, execution, monitoring, testing and improving into the very fabric of everything Meggitt makes and does.

Over the last two years McMurray has overseen the creation of a robust quality management organisation strong on networking. "Sites share challenges, solutions and leading practice as a matter of routine now because site-level quality directors know each other

from attending quality conferences and workshops when they worked together on quality task forces. There has also been very substantial investment in expertise, and a lot of new faces, right across the organisation. The appointment of divisional quality directors replaced 40-something contact points with five. At the group level, we have appointed four regional quality managers to support central governance, applying risk assessment to each site's quality performance and providing intensive support where it's needed. Now we are recruiting more than 120 people, all of them new to Meggitt but with existing quality experience. They will focus purely on improving our quality and delivery performance." The QMS team also works closely with Martin Calland's procurement operation (see page 17) to develop Meggitt's quality requirements for suppliers. "Our customers see all of this—the effort, the investment, the commitment—and they really understand and appreciate what we are doing," he says.

McMurray has experienced first-hand the quality management challenge facing business units and divisions. He understands very well that some are squaring up to quality and delivery targets tougher than they have ever seen before. But it's worth it, he reassures them. Conquering these challenges will not only benefit Meggitt's business, they will transform the

## Working for an organisation respected and admired for its quality, timeliness, skill and sheer professionalism: who wouldn't want to be part of all this?

daily experiences of everyone who works in it: "Fewer apologies to customers for things which didn't work out; fewer arguments with suppliers about things that didn't turn up; more time to feel good about the many more things going right first time; working for an organisation respected and admired for its quality, timeliness, skill and sheer professionalism. Who wouldn't want to be part of all this?"

In McMurray's book we are now on the right path to create a world-class operation in which everyone at Meggitt can take immense pride and which every Meggitt customer can trust absolutely. "This is not just a fantastic challenge," he says, "it's a fantastic opportunity." ●

## Getting to the root

The Meggitt-wide quality management business system uses structured codes to categorise and track every escape, symptom and ultimate cause.

A valve leak reported by a customer is given a **symptom** code.

Back at Meggitt, the pump is stripped. A hairline crack is found in the valve body and given a **cause** code.

A cascade of containment actions check stock and customer deliveries for other cracked pumps.

A systematic investigation begins, perhaps involving suppliers and sub-contractors, to make sure the **root cause**—it might be poor materials, rough handling or a machining misalignment—is tracked down and corrected permanently.

The entire process—investigation, problem solving, containment action and root cause follow-up—is given its own **corrective action** code.

Specialist management teams, called corrective action boards (CABs), track every escape, symptom and ultimate cause to ensure that the corrective action that's been taken has really got to the bottom of the problem, for once and for all and wherever in Meggitt similar weaknesses might arise.

Meanwhile, escapes are monitored and sifted by probability and potential total impact on the wider business and its reputation. A washer missing from a spares pack is not in the same league as a misaligned component which could jeopardise airworthiness. Careful weighting and prioritization of all escapes helps Meggitt get the balance right between driving down DPPM (defects parts per million) and keeping a weather eye out for that one, rare incident which could trigger something catastrophic.





## Diving deep

Ask any member of the Operational Excellence (OpEx) team where they expect to find the inspiration, leading practices and expertise for the next phase of Meggitt's competitive transformation—the creation of the Meggitt Production System (MPS)—and you will always get the same answer: from Meggitt itself. To paraphrase an American president: there is nothing wrong with Meggitt that can't be solved by everything that's right with Meggitt.

**THIS IS NOT COMPLACENCY.** A programme of eighteen 'deep dives'—each visiting a single production site and spending an intensive day getting to understand from the inside what it does and how it does it—has given Meggitt Production Systems Director Louis Chavez the confidence to speak for the senior OpEx team when he says: "we've seen enough to know that Meggitt has the core capability, talent and skill to build a Meggitt Production System far better than anything anyone else has. Although we don't yet have it all in one place, we will."

## We don't want to put people through 50 new things if they are great at doing 30 of them already and only need to be outstanding at ten ... we focus on getting those ten to the level we need

Each deep dive has several objectives. First, the OpEx team is there to get to know the realities of the site as it lives and breathes on a normal day. There are no long meetings in conference rooms looking at specially-prepared Powerpoints. The shop floor is the focus. Operations Intelligence and Management System Director Bernie Stevens: "We want to see close up the challenges faced by each site and how it tackles them. We look at the same information used daily to run the business—not special presentations. We debate and discuss real issues with management. Most importantly, we spend plenty of time on the shop floor, watching people work and, if they have the time, talking to them about what they are doing, how they are doing it, and what issues they face right there at the sharp end."

The deep dives are also a chance to assess the site's strengths and weaknesses, not to criticise but to help the OpEx team understand how best to implement the Meggitt Production System, trimming and adjusting to reflect the real shop floor needs they've observed. "The visits help us figure out how best to shrink the implementation and simplify deliverables without leaving something important undone," explains Chavez. "We don't want to put people through 50 new things if they are great at doing 30 of them already and only need to be outstanding at ten. We focus on getting those ten to the level we need." Along the way, great ideas and examples of leading practice are 'collected' as exemplars for the rest of the business.

Finally, each dive is an opportunity to update site and divisional leaders on progress with the Meggitt Production System programme as a whole, sharing insights and ideas from across Meggitt, and doing so in a way which actively demonstrates the spirit and practice of Lean leadership. "Throughout the deep dives,

we try to remain open, collaborative and reflective," says Stevens. "We leave plenty of time, not just to give feedback about what we've seen and heard, but to receive it about our own performance—how we might improve the deep dives themselves as well as other aspects of Meggitt Production System development and deployment."

The first few site visits did not get off to the best of starts. Stevens: "We made the mistake of not sharing enough information beforehand. In particular we had no agenda for the day. We just wanted to keep things fluid but it had the unintended consequence of creating uncertainty. That's been corrected now. We've also got better with practice and now we are finding sites phenomenally supportive."

**M**ost individual concerns have tended to come from people who fear change imposed against their wishes and a loss of personal responsibility for their work. "Once they understand our approach—that we are not trying to diminish their responsibilities in any way, that we are there to work with them to help improve performance—we have a different type of engagement altogether," says Stevens. "If you want major change like this to work, it can never be about doing things to people. It is always about encouraging them to understand, engage and contribute, and not just for the company's sake but for themselves."

The team has been making a special point of taking every opportunity to talk with operators and other technical staff. Chavez: "If we can do it without greatly disturbing their work, then

we engage with them to listen, learn and understand. These are important people with critical insight—the people who actually make the things Meggitt sells. They are 'gemba' personified, and we've had really good feedback from them about the deep dive process. Some have said that to have us there, engaging with the whole operation in this way, is extremely motivating for the whole site. It's great to hear that."

The first phase of Meggitt Production System development, including the deep dives, has focused on just 18 specially-selected sites. Why? "We are practicing what we preach," explains Stevens. "We can't do everything at once, so we are focusing on the sites where the new system can have the greatest impact and soonest." Does that mean the 18 are the weakest links or the strongest? "Neither. It's more subtle than that. They were selected according to a range of factors for their strategic significance to the Meggitt customer experience. This is about reaping competitive advantage, remember. We want to make the biggest difference in the shortest time." Come roll-out, the 18 will be whittled down to a first wave of eight for much the same reason; they will be the sites best able to deploy relatively quickly and so become showcases for the full Meggitt Production System.

At the time of writing, the OpEx team is very close to having completed its visits to all eighteen of the target sites, but that won't be the end of the deep dive process, says Stevens: "It's so important that we continue to get around the business regularly, seeing what's actually happening, talking to the people at the sharp end, gathering information and growing our understanding." So this wasn't a one-off exercise then? "No. They have been so useful and positive we will continue to use them as much as we can over the coming year, in fact they will become part of our standard work."



Amir Allahverdi

Louis Chavez

Ian McMurray

**Bernie Stevens**

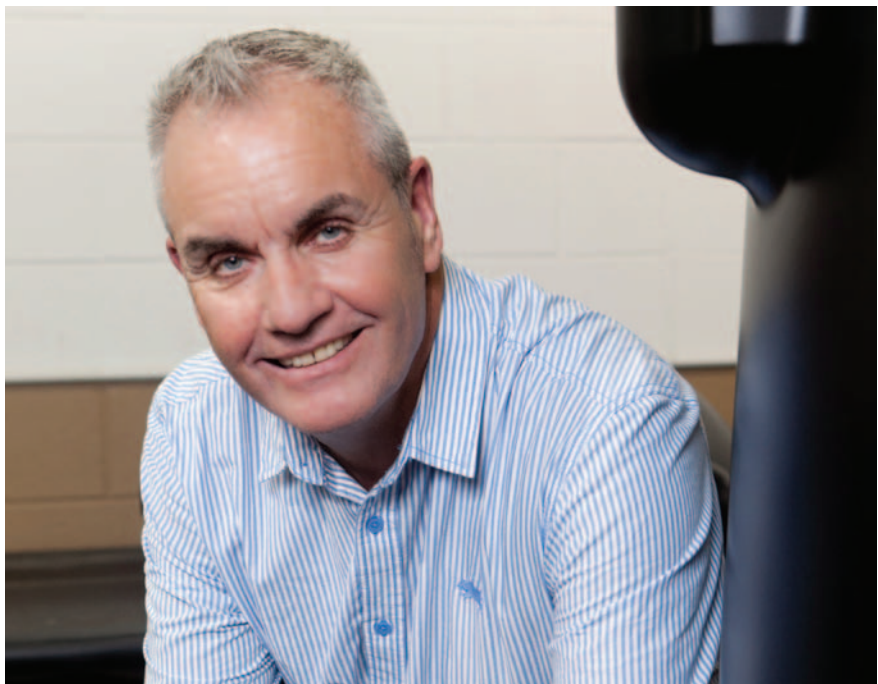
Martin Calland

It's not just a matter of being good at what we do. It's about excelling at it.

**BERNIE STEVENS IS NOT AN EASY MAN TO PIGEONHOLE** – a varied career in production as engineer, manager and director has seen to that.

As Meggitt's new Operations Strategy and Management System Director, he is working with Louis Chavez to develop a performance management system defining the nature and structure of standard work for all Meggitt's operational leadership teams. Quality and timeliness have become vital competitive differentiators in Meggitt's markets. The Meggitt Production System will help all 47 operating units improve their performance in both these areas but only if it is applied consistently and systematically. "I will be helping to establish the rhythm of our operations right across the business systems," explains Stevens, "giving production leaders the information, support, structured expectations and accountabilities they need to get the best out of the Meggitt Production System, and to improve their operational performance systematically."

Stevens will also be collaborating cross-functionally, focusing on ways in which the divisions can be helped to get early benefits from many of the changes the Meggitt Production System will introduce. "In these projects we will be focusing on creating tangible value for the business at large, helping divisions in ways which generate real financial benefits, in profit and working capital terms, whilst simultaneously helping them to prepare for the Meggitt Production System implementation." With a vast and varied experience base—embracing production, quality, procurement, continuous improvement, and more—and a highly collaborative management style developed in many senior positions, this is a role to which he is ideally suited.



**D**uring 25 years at Marconi Avionics/BAE Systems, Stevens rose through the ranks from apprentice engineer to production director; using Lean, 6Sigma and continuous improvement techniques to help lead an £200 million, 600-strong business to world-class performance levels. Stevens joined Meggitt in 2000 as general manager of Meggitt Avionics. There he built a Lean, process-focused, continuous improvement programme that trebled turnover and returned the business to healthy year-on-year profits growth. In March 2009, he was asked to lead Meggitt's engineering transformation; an experience that was transformative for him too. "We transformed Meggitt engineering in a very collaborative way. We engaged with people, amalgamated the best approaches and devised a set of common engineering

practices to be adopted right across the board. It taught me afresh exactly how powerful the collaborative approach can be, and showed me what tremendously good practices and excellent people we already have throughout the business."

**W**hen Stevens was subsequently given responsibility for the integration of Pacific Scientific (PacSci) at the beginning of 2011, he knew exactly where to start: "Within a fortnight I had all the leaders of the PacSci businesses in a two-day workshop, looking at how we were going to do this thing in a collaborative way. I understood the key milestones and the synergies we were expecting. But it was for them, the people who would actually make it happen, to tell me how we were going to get there. From then on my job →



was mostly making sure we had robust and rigorous ways to oversee, measure and hold people accountable.”

Stevens will be drawing on this considerable experience to contribute to a roster of projects in 2013 designed to create real and immediate value for the divisions through improvements in delivery, quality, cost control and working capital.

Quality delivered to customers improved dramatically in 2012. “These are sustainable benefits from real changes in the way Meggitt works,” says Stevens. “Now we need to systematically improve the cost of poor quality by focusing on the things that generate most of the opportunity: scrap, rework and warranty. In 2013, we will be working closely with the divisions to ensure we have the processes and data to identify and eliminate shortfalls and provide training for both.

**T**he new year will also see a continuing focus on cost reduction and how operations can better support divisional business objectives.”

A series of workshops will be designed to provide the detailed breakdowns and action plans individual facilities need to reduce inventory further.

Procurement-based initiatives in 2013 will include two Meggitt supplier conferences. Meggitt Control Systems held just such an event last year in Los Angeles. It was a great success. Group procurement

## We’ve seen great progress already in 2012—look at what’s been achieved in delivered quality—and there’ll be more dramatic performance improvements during 2013

now plans to run two similar events in 2013, talking about business challenges and future direction, and how the supply base can better help Meggitt achieve its objectives in quality, delivery and cost—for all of Meggitt’s main suppliers. (see profile: **Martin Calland, opposite**).

How Meggitt optimises its global resources—both in terms of getting the best out of its low-cost capabilities in Mexico and China, as well as optimising the shape and size of its extensive worldwide manufacturing footprint—will be another key priority for Stevens in 2013.

Almost all of this work, although targeted on delivering immediate business benefits, will include foundation elements of Meggitt Production System. New processes will always be Meggitt

Production System processes to support a natural, more fluid progression to full-scale implementation in due course. Indeed, an important overarching objective for Stevens and his colleagues in 2013 will be to get Meggitt Production System deliverables out early into the divisions, producing business benefits ahead of full-blown implementation. “Where we can see the benefits of sharing foundation work with the divisions, where there’s a benefit to them in putting things into practice sooner rather than later, then we will be looking for opportunities to do that.”

## The meaning of standard work

On the shop floor it is common practice to consult work instructions—standardised, written down, and supported by pictorial standards to clarify what needs to be done. Now the Meggitt Production System will apply similar principle of ‘standard work’ to managerial roles.

**DURING THE COURSE OF A WORKING DAY, WEEK, MONTH THERE NEEDS TO BE RHYTHM AND DISCIPLINE TO WHAT WE DO AS MANAGERS,** says Bernie Stevens.

“In leadership terms, ‘standard work’ means standardising the nuts and bolts of how we manage and oversee the operation flow, how we solve problems and the tools we use to do it, how we control what’s being done, and how we monitor and report.”

A key business benefit from applying standard work principles is that it separates the role from the person, making the organisation itself more robust: “Standard work is always well-documented so that if someone else needs to come in and perform that same role then they don’t have to reinvent the wheel.”

But big benefits are also felt by individual managers, says Stevens. “Standard work is a structure within which flair and creativity can be practiced in a disciplined way—rather like a script to an actor or sheet music to a musician. Having the basic disciplines of management and leadership decided right across Meggitt—standardising the nuts and bolts—can reduce decision fatigue and free managers’ energies to tackle the big stuff more effectively.”

**WE’VE SEEN GREAT PROGRESS ALREADY IN 2012.** Look at what’s been achieved in delivered quality—and there’ll be further performance improvements during 2013 and beyond,” says Stevens.

“The Meggitt Production System as a whole is all about building sustainable, long-term competitive advantage. So it’s not just a matter of being good at what we do, it’s about excelling at it.” In line with the approach adopted by a number of Meggitt’s strategic customers, the Meggitt Production System will award Gold, Silver and Bronze performance certifications. Roll-out will begin by the end of the first quarter of 2013, with the aim of having the first sites entering the Bronze stage in the last quarter. The rest will follow progressively over the next months, maturing eventually towards Silver and Gold.

The Meggitt Production System is no quick fix. It is more like a journey. “Finding those last few per cent which is the differentiator at the very top of our markets—the things that make customers want to come back because they can see we really are the best—is our ultimate objective.

“Ask any Olympian: those last few percentage points—getting from Silver to Gold—that’s the really tough part.” ●



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Amir Allahverdi

Louis Chavez

Ian McMurray

Bernie Stevens

# Martin Calland

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We talk about supply 'chains'. But when you see how many Meggitt customers are also suppliers, these are no longer chains but complex networks of mutual interdependence.

**COMPLEX AND MULTI-FACETED THOUGH MEGGITT IS**, Martin Calland, group head of procurement, has a striking vision that makes the group sound more organism than organisation: "We talk about supply 'chains', as if the relationships are still neat and linear. But when you see how many Meggitt customers are also suppliers, you realise that these are no longer chains but complex networks of mutual interdependence."

Meggitt is an extended organisation with interests and influences reaching inward and outward in all directions. Boundaries with customers and suppliers are sometimes blurred or elided. "Viewed in this way," says Calland, "we really are all in

this together. So what can we do to help our suppliers work more effectively? How can we help them to help us by finding ways to help them raise their game? These are now vital questions when it comes to improving our own operational effectiveness."

Calland's interest in the "essentially collaborative" core of the very best supply interactions was first pricked during his career at Rolls-Royce where he studied strategic supplier relationships, focusing on the 'interfaces' between organisations. What he learned is playing an important part in reshaping Meggitt's approach to its own supplier relationships: "There can be huge inefficiencies at the points where organisations touch," he says. "Every time we looked at these interfaces, even in partnership-type relationships, we'd find opportunities to create faster, more accurate and lower-cost systems by breaking down organisational barriers, building trust and reducing waste."

Sometimes the inefficiencies could even look like good practice: "Think of an engineering process in which a customer provides a specification but the supplier routinely recalculates everything. Or a supplier holding a certain inventory while the customer keeps its own matching stock. That's two of everything to achieve a single outcome."

Calland has spent his career in aerospace procurement. He started at Rolls-Royce as a graduate management trainee and stayed 21 years. "Management trainees try lots of different functions but from my first day in procurement I liked the breadth of business exposure and the challenge of working and negotiating with external organisations. I still do." →



Joining Meggitt in 2007 as head of European strategic sourcing, he was looking forward to fresh challenges in a smaller, fast-growing, change-oriented organisation. In due course, the US and Singapore-based international purchasing offices were added to his portfolio. "The real power of Meggitt procurement isn't in my team, it's out there in the 47 factories—

**A**t six years old, procurement is one of Meggitt's most mature group functions, ensuring that there's been no shortage of fresh challenges during Calland's five-year tenure. Almost continuous change, renewal and growth has required the procurement function to shift its focus constantly in support of the priorities of the business at large. "In

are and helping them to tackle any improvements."

## There can be huge inefficiencies at the points where organisations touch. Even in partnership-type relationships, we'd find opportunities to create faster, more accurate and lower-cost systems by breaking down organisational barriers, building trust and reducing waste

exactly where it should be. But sometimes Meggitt as a whole can only reap a full business benefit by adopting a group perspective and aggregating the market power of all its factories. That's where we come in." The ongoing right-sizing and restructuring of the global supplier base is a good example. "Some Meggitt businesses still have relatively local supply pools. Throw a 100-mile cordon around them and you'd capture 80% of their suppliers. That's not right for Meggitt's future supply chain. We need a better blend of global and local capabilities; fewer, bigger, better suppliers who can support the wider group."

Calland's team of category specialists manage Meggitt's common requirements for global services and materials: machining, casting, metals, electronics. "We expand the company's knowledge of suitable suppliers—their capabilities, locations, quality standards, OTD records, growth potential—and then work closely with the divisions to agree the final list of suitable candidates.

"For example, Meggitt spends over \$100 million each year on machining. The development of a network of machining partners across Asia, Europe and the US has played an important part in lowering costs and raising quality. Like all new Meggitt suppliers, they meet all the latest AS9100 quality accreditation and NADCAP process approvals, and are able to support Meggitt's future growth plans."

one sense our core mission is the same. Operations still want the same three things they have always wanted from us: good quality supplies, delivery on-time and at reasonable cost. But while cost reduction remains as important as ever to Meggitt, there is now a much greater emphasis on the levels of quality and on-time delivery we demand of our suppliers." He runs through the wide range of factors Meggitt now considers vanguard procurement issues: "What's our relationship like with our suppliers? How do we manage them? What signals do we send them about our needs, intentions and requirements—and how accurate are those signals? Do we change our minds a lot? Do we know how to work with suppliers so that we can give them what they need? Do we have the systems in place to do things efficiently and quickly? Can we manage change? These things lie beyond that traditional cost equation and we are now paying much more attention to them."

**S**uch questions anticipate significant change in the way divisions and production sites manage their own supplier relationships. "Here, our job is to bring staff from different sites together to transfer best practice. At the same time, we are identifying what the ideal procurement function should look in divisions and business units, understanding where the gaps in capability

**T**here will be ramifications for some suppliers too. "We've got many, many superb suppliers. Others are not in this league and are having a negative impact on the quality of Meggitt's own operations." What happens next mirrors the 'deep dive' work being done at Meggitt's own production sites (see page 14, 'Diving Deep').

"Our own deep dive-style meetings are providing us with first-hand opportunities to sharpen our understanding of what suppliers need to do and how we can help them," says Calland who is encouraging Meggitt sites to share their knowledge and good practices with suppliers. He knows the benefits will feed into Meggitt's own performance. "I have just come back from France, visiting a Meggitt Equipment Group site and one of its suppliers. The supplier was grappling with problems that MEG had already solved. I said: "Let's invite them in and show them how you do it. A lot of what we are doing with suppliers now is this kind of sharing, coaching, encouraging."

The deep dive visits, along with everything that flows from them, have proved so fruitful that Calland is determined to see them formally embedded in the early 'discovery' stage of Meggitt Production System implementation. "The changes we are making to our own business and operations are exactly the kind of things our suppliers need to be doing to make their own operations more successful." •

## While cost reduction remains important, there is greater emphasis on the levels of quality and on-time delivery we demand of suppliers



Lookout for our dedicated series of quarterly Meggitt Production System communications throughout 2013.

# FACTORY FOCUS

## SURFIN' GAS

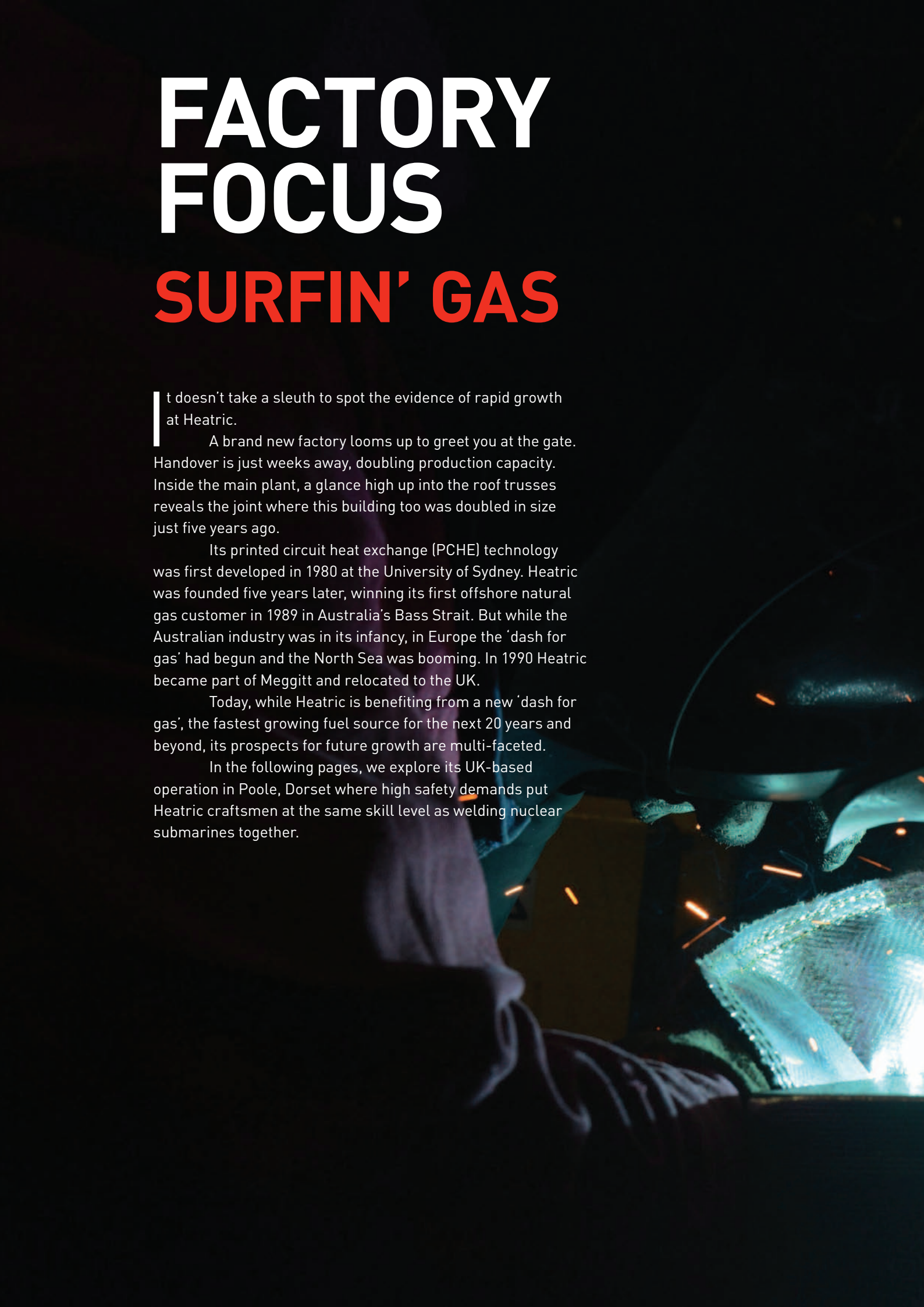
It doesn't take a sleuth to spot the evidence of rapid growth at Heatric.

A brand new factory looms up to greet you at the gate. Handover is just weeks away, doubling production capacity. Inside the main plant, a glance high up into the roof trusses reveals the joint where this building too was doubled in size just five years ago.

Its printed circuit heat exchange (PCHE) technology was first developed in 1980 at the University of Sydney. Heatric was founded five years later, winning its first offshore natural gas customer in 1989 in Australia's Bass Strait. But while the Australian industry was in its infancy, in Europe the 'dash for gas' had begun and the North Sea was booming. In 1990 Heatric became part of Meggitt and relocated to the UK.

Today, while Heatric is benefiting from a new 'dash for gas', the fastest growing fuel source for the next 20 years and beyond, its prospects for future growth are multi-faceted.

In the following pages, we explore its UK-based operation in Poole, Dorset where high safety demands put Heatric craftsmen at the same skill level as welding nuclear submarines together.







The deep runs of perfect weld around thick, complex joints, demand the finest hand-eye control and close attention to the delicately shifting sensations of light, heat and sound. Even seasoned professionals get a surprise when they see its quality.

# Heatric: Unlocking the future

Heat exchangers are a core technology in the offshore production of natural gas. For 25 years Heatric's unique diffusion-bonded, micro-channel heat exchangers, known as printed circuit heat exchangers (PCHEs), have led the competition on every significant performance point. Their lighter weight and greater efficiency make them much more compact. Their inherent structural integrity makes them safer and more robust, able to handle higher pressures and temperatures and to withstand extreme operating conditions. This, then, is classic Meggitt territory: smart technology and extreme environments. With gas use booming and exciting new applications in other sectors starting to crowd the development 'pipeline', the Heatric story is really hotting up.

## IT'S BEEN TEN YEARS SINCE I FELT THIS GOOD

about coming to work," says Heatric's Managing Director, Adrian Tattersall. He took up the post in 2008, via biofuels and plant manufacturing, after a 20-year career with ICI. Since his arrival at the start of the credit crunch, Heatric has doubled its sales almost every year. He is clearly enjoying managing such a high growth business. "When you are forced to shrink a business, the situation is hard but the decisions are reasonably straightforward; you have to shed capacity to survive, so the big question is what are you going to keep?"

But in a fast-growing business like Heatric, Tattersall observes that the judgements and the decision points are much less well-defined. "You have to manage that uncertainty to succeed. We are constantly looking for new applications and new markets, trying to find the best people, building our capacity and skills, investing in new machinery and buildings. But all the time we're never entirely sure which people will thrive, which applications will be winners, which markets will fly. So there's always an unknown quality to leading a high growth business, and that's really exhilarating."

## Growing the business by growing its people

There's no such thing as 'off-the-shelf' at Heatric. Every product is tailored to the customer's detailed 'problem statement'. This might well define not only the physics of finely calibrated gas and liquid flows, temperatures and pressures, but also the hurricane wind speeds and 100-year wave sizes that can be expected during a 25-year life, hundreds of kilometres offshore.

Bespoke production places an especially high premium on people and skills, says Tattersall: "Designing and



It's ten years since I felt this good about coming to work

*Left: Exhilarated:* Adrian Tattersall, Heatric's Managing Director

*Right:* Heatric promotional graphic for American Society of Mechanical Engineers Turbo Expo 2012: while Heatric is well-known in the oil and gas industry, PCHEs are ideally suited to modern power generation processes, especially those using advanced working fluids such as helium or super-critical CO<sub>2</sub>. (See Renaud Le Pierres on 'Emerging futures', page 27)



building PCHEs is very demanding and you need plenty of very skilled people. They are the bedrock of our production capacity. We keep a very close eye on the skills matrix of the engineering and fabrication teams, and it is an important part of management's job to make sure they realise just how important they are to us."

A workforce of 105 three years ago is 250 now. More than a third of those newer recruits are welder/fabricators; another quarter are engineers; almost all of them are young. Tour the shopfloor and the average age can't be much more than 30. Stick your head round the door of the canteen at lunchtime and mostly what you'll hear is laughter. Even after 25 years, Heatric remains a young company for one reason: its answer to the global shortage of engineers and craftspeople has been to grow its own talent.

"We do a lot of training," says Tattersall. "We took on six apprentices this year—there's 14 in total now—and there's always someone raising or refreshing their skills. Even experienced welder/fabricators never arrive with all the skills we need. It typically takes a year to get even a very good general welder up to speed. Tricky materials, like heavy gauge stainless steel, and very high safety demands put us at the same skill level as welding together nuclear submarines. We are subject to the same inspection regimes as well."

Heatric also welcomes engineering interns, many of whom go on to become graduate recruits. "We have a structured graduate training programme for them too. They get careful mentoring, early responsibility, lots of opportunities to grow and travel, chances to interact with clients, and good rewards. Some stay as pure engineers, others move into customer-facing technical roles."

Tattersall and his team have clearly got their people management and motivation right. Retention is very good and it's not uncommon for Heatric to go a whole month without a staff absence. And those aren't the only indicators of a contented workplace: the company has just celebrated a whole year without a health and safety incident that required

### Getting closer to customers

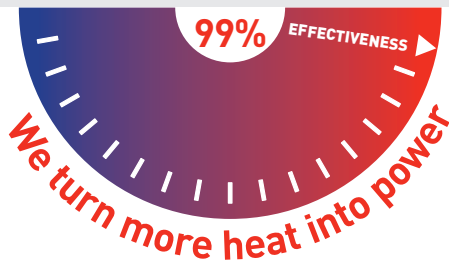
Another key to Heatric's future, believes Tattersall, will be its success in getting closer to its customers and delivering not only what they want in technical terms but doing so in ways that support their wider commercial needs. To this end, and in addition to its traditional sales function, Heatric now has two more customer-facing teams; one dedicated to working closely with customers who are themselves using Heatric PCHE technology to develop new applications and technologies, the other growing Heatric's after-sales and customer services.

Since 2009 Heatric has been making significant investments in the aftermarket and it remains a development priority: "This area of the business contributed one-third

## Even after 25 years, Heatric remains such a young company for one reason: its answer to the global shortage of engineers and craftspeople has been to grow its own talent

official reporting (known as 'Riddors' in the trade, after the *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, 1995*).

of turnover in 2010 and we are planning further significant growth over the next three to four years, improving our response times and, most importantly, reducing →



25 YEARS  
OF HEAT  
EXCHANGE  
EXPERIENCE

Reliable, compact and highly efficient, our diffusion-bonded heat exchangers have led the field for 25 years.

COMPACT BUT POWERFUL



customer downtime.” A department that hardly existed five years ago can already pride itself on putting a Heatric engineer into a customer site anywhere in the world within 48 hours. In 2012 that included customers in South Korea, Vietnam, Australia, Brazil, Norway, Qatar UAE, Denmark, USA, Canada, Singapore and Scotland.

Developing a symbiosis between the urgent and unpredictable needs of a customer in crisis and the long, predictable timelines of original equipment

manufacture (OEM) is a particular challenge: “For a business confident in the quality of its OEM technology the after-sales market can seem like a sideshow. That is an easy but expensive mistake to make,” says Tattersall. “There’s now a growing company-wide understanding that good customer care can generate more OEM sales. It flies the Heatric flag long after the original installation and ensures we remain at the heart of customers’ operations and thinking about requirements. Putting in

place what’s needed to deliver an effective customer support operation—flexibility, rapid response, a louder voice for the customer —has also helped the rest of Heatric to improve its own customer focus. The recent big contract wins have brought with them some real challenges, both for individuals and for the business as a whole. These days our customers are bigger and more demanding, and we’ve got to match their high standards of professionalism, thoroughness and rigour with our own.” ●



A department that hardly existed five years ago can already pride itself on putting a Heatric engineer into a customer site anywhere in the world within 48 hours

*Left: Top talent:* Ricky Schwarzin (18) and Jake Bascombe (21) joined Heatric’s first-year apprentice scheme in 2011, completing their ASME welder qualification codings rapidly, including the 6G weld test, a fixed 45° position. *Below:* Fabrication Technical Manager Andy Foyle says many experienced welders do not acquire this qualification. You can read more about the demanding craft of PCHE welding on page 28.

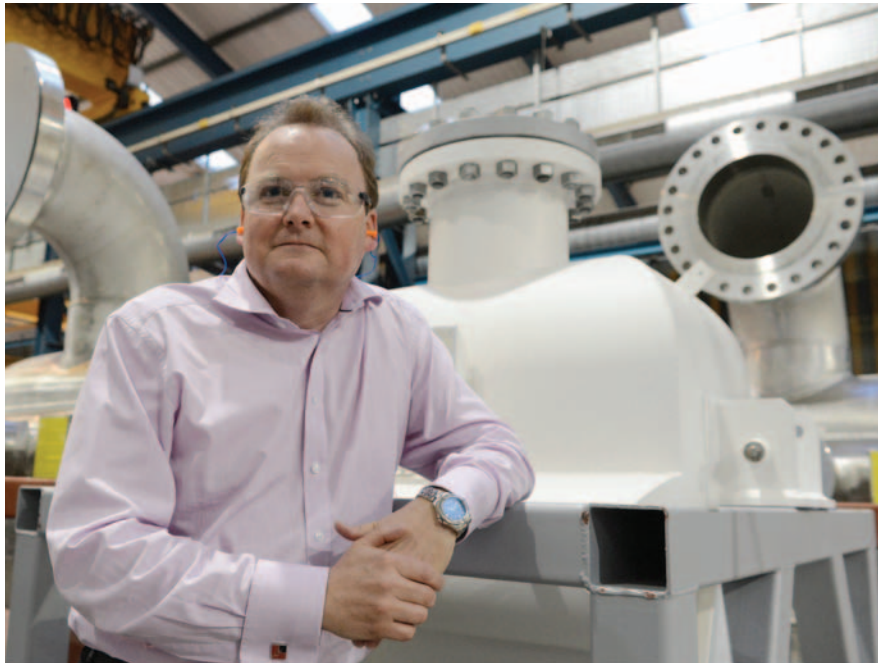


# The new dash for gas

**P**CHE technology was first developed in 1980 at the University of Sydney. Heatric was founded five years later, and won its first offshore natural gas customer in 1989 in Australia's Bass Strait. But while the Australian industry was in its infancy, in Europe the 'dash for gas' had begun and the North Sea was booming. In 1990 Heatric became part of Meggitt and relocated to the UK.

Today Heatric is benefiting from a new 'dash for gas'. This time it's global, powered by a thoroughly modern mix of economics and climate. Burning natural gas instead of coal can reduce CO<sub>2</sub> emissions by 40%. Current gas prices are about half the coal equivalent, having fallen by almost two thirds since 2008. There is now a world-wide expectation that natural gas will be the fastest growing fuel source for the next 20 years and beyond.

In fact, the prospects for Heatric's future growth are much more interesting than a simple gas boom, good business news though that undoubtedly is. Operating in some of the planet's most challenging environments, offshore energy companies must strike a judicious balance between innovation and safety and they tend to be



Above: Nick Johnston, Heatric's Director of Sales

## Competing with 19th century technology

Sales Director Nick Johnston explains: "As part of the process before it is sent ashore, the natural gas that comes up from the ocean floor has to be purified, compressed and cooled. So heat exchangers are a core technology in gas processing. 'Shell and tube' (S&T) units have a long history in this application, but next to our PCHE units they look like what they are—an over-bulky hangover from the steam age. Typically one of our PCHEs will be four

separate component parts and joints which vibration and corrosion can easily weaken. Under pressure, even tiny leaks have a habit of becoming catastrophic as tubes break wide open and adjacent tubes are damaged.

The contrast with the high integrity of PCHEs could hardly be more stark, as Johnston explains: "The heart of a PCHE is a joint-less, self-supporting matrix of micro channels, set within what is, in effect, a block of solid metal. This makes them much more vibration- and

## The unique ability of Heatric technology to unlock wider performance, safety and build-cost benefits was central to the decision by Petrobras, oil giant, to make PCHEs standard on eight new LNG ships

quite technologically conservative. But now there is a growing recognition among gas operators, whether they are eager to boost output through existing platforms or to optimise their often-innovative new-build projects, that Heatric's PCHE technology can provide something akin to the Holy Grail: higher output *and* better safety. For existing platforms that means de-bottlenecking the gas production process, using robust, compact PCHEs that, size-for-size, boost throughput and overall system integrity simultaneously. On new platforms, PCHEs offer the opportunity to design-in higher efficiency, safety and durability from the start, using compact technology to unlock a host of additional financial and operational benefits.

to six times lighter and smaller than the equivalent S&T unit, enabling much higher throughput for a given size. PCHEs are also better at handling high pressure, up to 650 bar (almost 8700psi), as well as very high pressure differentials. Comfortable operating temperatures range from 'cryogenic' (i.e. below -150°C) to 900°C. The multi-fluid capabilities of this technology enable a single PCHE to replace several conventional units in certain applications."

Rather at odds with its long use, S&T technology has a failure mode ill-suited to gas production, especially in harsh offshore environments. The gas runs through supported tubes inside a chamber containing the coolant. There are many

shock-resistant than any competing heat exchanger system, and 100 times less likely to develop a leak. If a leak does occur, it remains contained and easy to control, effectively eliminating the likelihood of a catastrophic failure. Our sophisticated manufacturing processes also enable us to make PCHEs from a range of corrosion-resistant materials, giving them lifespans of 25 years-plus, matching those of the offshore installations of which they are an integral part."

Space, or rather the lack of it, is another key constraint on an offshore platform and here S&T technology is again found to be at a profound disadvantage to PCHEs: "If you want to expand production on an existing offshore platform, you can't



just buy the plot next door and move the fence. You have to get more out of the space you've got, which means you need more compact systems that can give the same or better performance on a smaller footprint. This is not something S&T heat exchangers can ever deliver. Retro-fitting our compact, high efficiency PCHes removes that bottleneck at a stroke."

### New-build

But the power of PCHes as an unlocking technology is most fully realised in new-build projects. Compactness, integrity and high efficiency together create a multiplier effect which reduces topside bulk, simplifies construction and can cut total build-costs by millions of dollars in the process. For one customer, the use of compact PCHes eliminated one full deck from its gas compression module, simplifying construction and triggering a package of other construction savings (such as reducing the height of the helideck) which totalled \$6m. For another, reductions in the size and weight of each of three decks saved money but also enabled final assembly to be completed in a single lift

by one of the vast floating cranes that cost thousands of dollars a day to hire. Total construction saving: \$15 million.

The 18 high pressure, high duty PCHes to be fitted to the Shell Prelude Floating LNG Platform will save between 1000-1500 tons of topside weight on a vessel displacing 600,000 tons, significantly lowering its centre of gravity and improving stability in the cyclones and 20-metre waves it will encounter 200 miles offshore. Heatric PCHes will enable this vessel, the very first floating LNG facility of its kind and the world's largest floating offshore construction, to chill natural gas to -162°C, shrinking its volume 600 times so it can be shipped to customers all over the world. (See Meggitt Review, Winter 2011/12 for more on this story.)

### Global expansion

Over the last 20 years some 1700 Heatric PCHes have been installed all over the world. The Shell Prelude project is expected to be the first of many new opportunities in a buoyant Australian market. Energy-hungry China also shows great promise, as you would expect. But it

is in Brasil that Heatric's policy of keeping close to its international customers, and serving them from a local base staffed by local people, has really borne fruit.

At the beginning of the year, Meggitt Brasil was established to support this most promising of Heatric international markets, though Heatric has been in Brasil for more than a decade already. An initial Heatric staff of four has since increased to ten, and the new company now represents several other Meggitt businesses.

The unique ability of Heatric technology to unlock wider performance, safety and build-cost benefits was central to the decision by Petrobras, the state-owned oil giant, to make PCHes standard on eight new FPSOs to be built over the next four years. In total Heatric will supply over 200 PCHes for floating, production, storage and offloading (FPSO) vessels in the Lula and Guara Pre-Salt fields in the Santos Basin, offshore Brasil, with the majority of them being assembled locally by Meggitt Brasil using local suppliers for materials sourcing, project management, fabrication, training, aftermarket services and field support. ●

**Surfing gas: 26 Heatric PCHes will feature in gas compression, gas injection and CO<sub>2</sub> separation modules in each of eight Petrobras' floating production, storage and offloading (FPSO) vessels like this in the Lula and Guara Pre-Salt fields in the Santos Basin, offshore Brazil.**





# Emerging futures

**H**eatric has set itself the target of finding one third of its business from 'emerging technologies' by 2016. Three areas in particular are the most promising.

## Waste heat recovery

Waste heat recovery (WHR) captures heat that would otherwise be lost up a chimney, flue or power station cooling tower, then uses it to generate electricity. In power stations waste heat recovery helps generators lower their unit production costs. Elsewhere, the business case is a simple trade-off between capital costs and the savings from smaller energy bills and lower carbon taxes. Heat exchanger efficiency is, then, at the very heart of these economic viability calculations. The compact size and high efficiency of PCHE-based WHR systems also make them easy to retrofit where space is limited in existing plants. Shell and tube units could theoretically do the same job, but high capital costs blow the economic case, and their bulk makes retro-fitting almost impossible.

US firm Echogen, for example, is using supercritical carbon dioxide as the working fluid inside Heatric PCHEs to turn much more of the waste heat into electricity. (CO<sub>2</sub> becomes supercritical when it has been heated and pressurised until it behaves like a liquid and a gas simultaneously.) Echogen chose Heatric PCHE not just for their compactness, strength and high working pressures, but also because they can deliver the very close heat and pressure control

needed to optimise process efficiency. [See Winter 2011/12 edition of the Meggitt Review for more on this application.]

## Chemical processing

The compactness, integrity and efficiency of Heatric's PCHEs is also helping to remove multiple technical boundaries in chemical processing, increasing process throughput and safety.

Higher throughput in chemical processing usually means more risk from higher temperatures and pressures as well as the use of hard-to-handle process fluids. But Heatric's diffusion bonding produces exceptional integrity at high temperature and pressure, while the etched micro-

matrices tailored to almost any combination of customer process requirements.

## Air processing

Air processing is the industrial separation of atmospheric air into its constituent gases, mostly nitrogen, oxygen and argon. This is traditionally achieved by cryogenic distillation which uses very large amounts of energy to refrigerate air to -195°C at which point it becomes liquid and the constituent gases can be 'boiled off' progressively.

For some years Heatric has supplied PCHE heat exchangers for air processing applications in which safety has been a particular problem. Now, in a similar way to chemical processing, air processing

## The unique ability of Heatric technology to unlock wider performance, safety and build-cost benefits was central to the decision by Petrobras, oil giant, to make PCHEs standard on eight new LNG ships

channels (that replace S&T tube-work) enable the use of much smaller amounts of quite dangerous chemicals.

Chemical processing makes complex demands on heat exchangers. Sometimes it's a heating process, sometimes cooling; sometimes the cooling and heating may come from the process itself generating or absorbing heat; and sometimes these processes will require two components to be mixed inside the heat exchanger. The flexibility of Heatric's channel modelling process makes it possible to design internal

customers are being helped to unlock new, more challenging techniques, offering better efficiency and reduced energy costs, while safety is improved by reducing the active inventory of difficult gases. •

*Below right:* Will Peat masks the exchanger nameplate to keep it clean during the final painting process, Will is part of the team who put the finishing touches to the product for release to the customer.

*Below left:* Renaud Le Pierres, Heatric's business development engineer, explores the promise of emerging technologies.





## The secret of PCHE

The unique power of PCHEs as an 'unlocking' technology flows from two extraordinary production techniques, both of which only Heatric can perform at the industrial scale.

### Printed circuit

Instead of the large-bore pipe-work of a traditional shell and tube (S&T) heat exchanger, process fluids and gases passing through a Heatric PCHE travel along maze-like complexes of micro-channels chemically-etched into the surface of rectangular plates. The twists and turns of these channels are custom-designed to maximise performance for specific applications. Adjustments to the channel path, diameter and wall-thickness can all be computer-modelled and remodelled quickly and efficiently, enabling them to be optimised for fluid types, in-process mixing, multiple liquid and gas combinations, extremes of temperature and pressure and wide differentials in the two. The direct link between software and metal thus makes PCHE a fantastically flexible technology. Only Heatric can do

it on a commercial scale because it is so difficult to execute at this high level of precision and channel depth.

### Diffusion-bonding

Layers of the finished, etched plates are then diffusion-bonded into what at first sight resembles a solid block of the parent metal with engineered holes. Under a microscope, the metal is granular. Diffusion-bonding promotes grain growth across the plate interface, joining them together without melting or deformation. There is no welding or brazing, no flux or filler; the complex networks of micro-channels, deep inside the block, retain their perfect form and function. This matrix is the functional heart of a Heatric PCHE. Diffusion-bonding is a well-known process but again, only Heatric can do this on a commercial scale to the high quality standards required by its customers.

Diffusion-bonding thus creates a joint-less PCHE core matrix that is as strong as a solid block of the parent metal. Its printed circuit micro-channels allow it to flow many times more fluid for a given size. The combination of computerised modelling and chemical etching make it possible to fine-tune the matrix to the most exacting standards and requirements. As a result, PCHEs are inherently light, robust, safe and highly efficient.

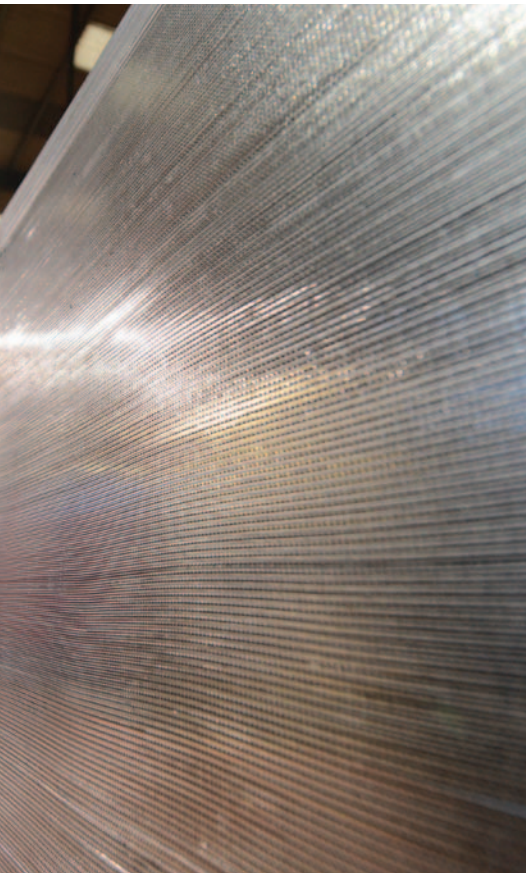
## Channel design

There are very few production constraints on the complex route a channel can take across a plate. If Heatric's design engineers can draw it, the chemical etching process can render it in metal.

Each project starts with the customer's process data sheet. It details the fluids involved, their key physical properties (density, thermal conductivity, viscosity), and critical pressures and temperatures in and out. Many of the trickiest design challenges stem from the inescapable trade-off between pressure drop and heat transfer. Fluid turbulence, which has been deliberately introduced to increase heat transfer, might reduce exit pressure by too much. It's a fine line to tread, and all the while the system also needs to be as compact as possible, because offshore space constraints are absolute, and smaller almost always means cheaper-to-make as well.

Even the simplest PCHE must optimise the pressure and temperature drops for two liquids (e.g. hot gas and coolant) and some are designed for three or more. So, the design can be manipulated in detail to achieve the outcome desired by the customer.





## Welding

Even seasoned old pros get a surprise when they see the quality of the welding at Heatric.

The deep runs of perfect weld, around thick, complex joints, demand the finest hand-eye control and close attention to the delicately shifting sensations of light, heat and sound.

To make a PCHE, multiple matrices must first be joined together, then the manifolds attached; all by precise, high-quality welding. An electric arc is struck between a metal wire electrode and the components being joined. The intense heat of the arc causes the wire and the workpiece to melt and fuse. As the joint forms, a shielding gas protects it from nitrogen and oxygen in the atmosphere, which might otherwise make it porous or brittle.

For a cylindrical joint (of which there can be several on a single PCHE), the work piece is mounted on a foot-controlled turntable, while the other foot regulates the current flowing to the electrode. At the business end, the arc is a dynamic, pool of light and molten metal guided by the welder and continually shaped to suit the geometry of the joint being created. Special gloves help operators retain the light touch that is vital in precision welding, and the welder wears a state-of-the-art helmet ('screen'), with its own air feed and digitally-controlled reactolite visor. Every movement of every limb, and every sense too, is thus focused on the point where electrode and metal meet in an arc of blinding light.

Get it right and your reward is the sound of gently frying bacon! The continuous run of frozen, softly-lapping weld waves may look delicate and beautiful, but the joint is as strong as the parent metal.

*Top left:* Boguslaw Puchalski attaches the metal sheathing that protects the stainless steel core from the wet and salty environment the PCHE will encounter offshore. The sheathing is more robust than any painted coating.

*Centre:* Diffusion-bonded block

*Top right and below:* Mike Walbrin welds diffusion-bonded blocks together to form the core of a PCHE.

We keep a very close eye on the skills matrix of the engineering and fabrication teams, and it is an important part of management's job to make sure they realise just how important they are to us