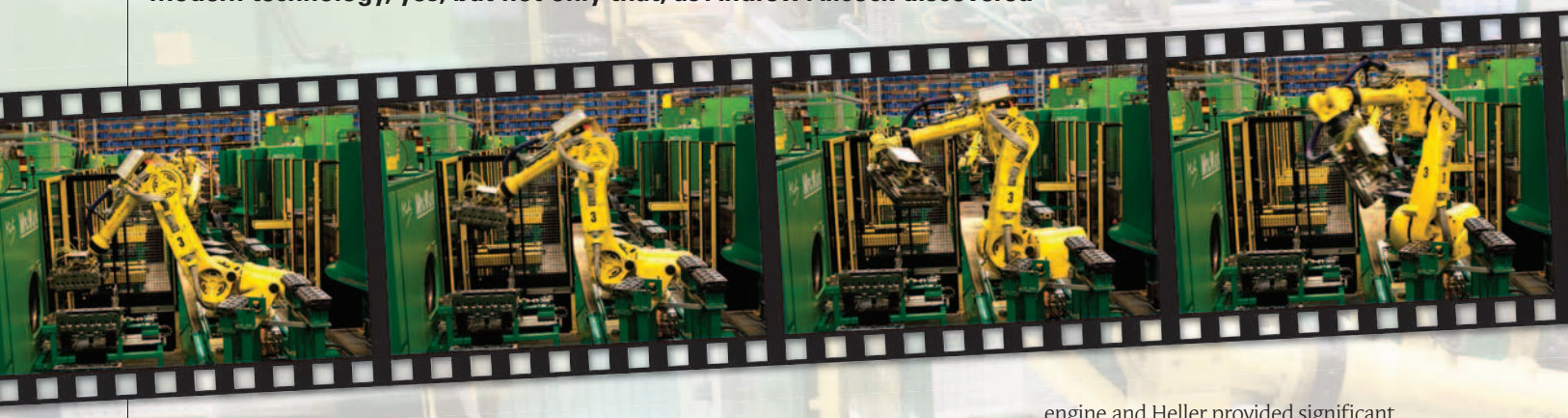
Globally competitive

What did it take to reverse entrenched outsourcing at a the UK site of a global manufacturing company? Modern technology, yes, but not only that, as Andrew Allcock discovered



A $9 million investment in a flexible, automated cylinder head machining system (see box item page 14) at diesel engine manufacturer Perkins Engines, Peterborough, is a signal that the trend to outsource manufactured components can be successfully challenged. Further investment is already underway at Perkins, with yet more under discussion.

This is a clear statement that manufacturing in this country can be cost-competitive – indeed, this automated machining system is delivering a part cost that offers a "60 per cent cost advantage" compared to competitive quotes received from France, China and Turkey.

And while it is a technological solution that has delivered this achievement, the story has its roots in a changed approach to machining and manufacturing engineering within Perkins Engines, part of the Caterpillar organisation.

A few years ago, even bidding for such work would have been out of the question because Perkins' track record in efficient machining at Peterborough was far from glorious, hence the outsource trend.

"Machining was considered to be dying at Perkins," reflects Tony Green, manufacturing coach of the machining centre of excellence. "This is the first machined part we have brought in house. The flow was in the opposite direction."

A new manufacturing engineering team structure was introduced some four to five years ago with the arrival of Andy Wheatcroft, technical resources manager, from Caterpillar's Belgium plant, where he was financial controller – he is both a manufacturing engineer and a chartered accountant. This structural change has inspired a "more professional" approach to manufacturing, with a business-led, Six Sigma ethos. Another element was a TPM approach (Total Productive Maintenance) to manufacturing technology support – involving some 16,000 TPM schedules.

EVERY DAY WE MAKE THE PLAN

This change of approach was key in 'turning round' a 13-year-old 'failing' Heller machining installation, taking it from an Overall Equipment Effectiveness (OEE) figure of 35-38 to 80 per cent. "Every day we have a plan and every day we make the plan: it's great," Mr Green enthuses.

The installation is employed in the manufacture of blocks for a three-cylinder engine and Heller provided significant support to help Perkins first achieve and then maintain this performance.

Yet another machining installation, this time a Renault transfer line, has been improved so much that where once three shifts were incapable of meeting production schedules, a complete shift has been eliminated and the required production volume is met in two.

"One of the reasons machining was dying here was because we didn't do a great job of understanding machining and what it required to make it effective and efficient; indeed, that's why I joined the technical resources team. At the time, machining was halting assembly tracks," which Mr Green describes as "a disaster".

He is a Master Six Sigma Black Belt and joined the technical resources team to create and manage the now established Peterborough machining business – maintenance/operations and operational manufacturing engineering teams, as a single entity. "Now we have a professional machining environment. Indeed, every one of our apprentices wants to go into machining: formerly none of them wanted to," he confirms.

Over the past two years, this professional approach has been subsumed

in the UK

within the Caterpillar Production System, a global initiative of some two years' standing at Peterborough. This underpins Caterpillar's 'Vision 2020' where it aims for "market leadership for every product group on every continent".

So it was this structural change and subsequent demonstration of Perkins' ability to operate an existing high technology machining facility efficiently that set the scene for Perkins' first major machining investment in over 10 years.

JOINT VENTURE ENGINE

The four-pot cylinder head made in the new cell is for an engine built by a separate joint venture company on the Peterborough site. The joint venture is between Perkins (70 per cent) and Japan's Ishikawajima Shibaura Machinery (ISM) Company (30 per cent). The engine is an ISM design and is installed in a diverse range of equipment, including professional turf machinery, marine, construction, material handling, electric power generation and so on. Engines are badged according to the customer, with Peterborough supplying them into Europe. There is also a sister facility in Griffin, Georgia, to which the heads are exported, and a new facility in Wuxi, China, currently being developed.

Engine build rate has grown over the past six or seven years from a few thousand engine units to 140,000 today (taking in both three- and four-cylinder designs). The plan was always to localise as much content as possible, explains Mr Green, but with those parts that are "volume critical", such as head bolts, made in Japan. Other parts for the engine were outsourced, as with any other engine, with cylinder head manufacturing 'Europeanised' by moving the manufacture of the four-cylinder unit from Japan to a French sub-contractor.

An emissions-related design change to the four-cylinder engine provided the opening for Perkins, and others, to bid for the work in a global competition. Heller was in competition with other businesses, all presenting their initial proposals to a selection committee, which included Mr

Carring buffer stock with each robot helps boost system efficiency

A third robot is used to load raw material to the input conveyor and also to provide further inter-operation handling outside of machining

Green, then in his maintenance role plus Mr Wheatcroft and others.

Proposals were whittled down to two in a now typical Perkins scientific manner using the Pugh Matrix, Six Sigma quantitative analysis – cost, quality, reliability, support, aftermarket care, technology level, and so on. The final two contenders were then put through a similar process and the performance of the 'rescued' 13-year-old Heller installation was a big factor in Heller's success.

'SHOULD COST' APPROACH

Working together with Heller Machine Tools, Perkins manufacturing engineering teams developed a solution using what Mr Green describes as a 'should cost' approach. "Because this was a brand new part, it had to be completely re-engineered. We worked out exactly what we believed the part 'should cost' to make – an approach that we apply generally now for major components. So what it cost before is almost irrelevant; our manufacturing engineering team worked out the cost based on its material and work content, taking in everything – material, machine cost, machining time, tooling, coolant, energy, and so on."

Heller was part of the process, working closely with the Perkins team. "It wasn't a simultaneous engineering approach, but a very close alliance. We have formulae that we have built up over many years to support precise cost modelling," explains Heller's proposals manager, Steve Masters. "Different solutions and 'what-ifs' were batted backwards and forwards and this, I believe, is what drove the cost down." In total, this development phase took some four months, he recalls.

Mr Green adds: "We have a very strong partnership approach with Heller, not just in the development phase but also in maintenance, asset care, plus training and development – we send our apprentices to Heller in Germany and Redditch, for example. We understand that we too hold supplier reputations in our hands, we need to support them by doing a great job of running their machines effectively just as much as they need to support us."

Based on sales forecasts, the machining facility was designed to manufacture 85,000 cylinder heads over five three-shift days at an OEE of 85 per cent which meant a production output of 13.6 cylinder heads/hour. Benchmark cost and quality criteria were given conditions, of course.

Working down through the detail, Heller used Cut View software to determine cycle times, which gives the number of machines (six), and then the issue of production flow was considered, taking into consideration the impact of equipment failure or breakdown.

A visit to Heller in Germany to view the company's ModuLine machines used in multi-machine systems demonstrated how the company can deal with machine failure. "A ModuLine system can redistribute tools to make sure that parts can still be made," Mr Green explains. "We don't quite have this system here, but we do have a mirrored system."

Mr Masters adds: "The real drive for us

Technology to break the outsource cycle

The manufacturing cell comprises six identical Heller MCH250 horizontal machining centres. Three Fanuc robots feature: one providing initial loading of pre-machined heads to an input conveyor and also the loading of finished products to a leak test machine; a further two transferring parts from the input conveyor to/from the machines, to/from MecWash washing machines [2] and to/from assembly operation input and output conveyors. The assembly of valve stem guides and valve seats is an intermediate, automatic process undertaken on a special-purpose River Circle machine. If the River Circle machine were to fail, then manual assembly is the fallback. The final stage is manual hot plug assembly and sealing prior to leak testing.

The cell is mirrored: three Heller machines one MecWash unit and a robot in each half. If a machine fails, then the system will still produce, the Fanuc robots being able to overlap each other to access machines.

was to design a system with a very high uptime because it was planned to be able run it 24 hours/day, seven days a week [although not intended to operate like this immediately]. So if any one machine goes down, it does not prevent the system from producing, although output will be reduced." It is also possible, if necessary, to isolate one half of the mirrored cell from the other.

A Heller system simulation, using Flexsim software, provided the means to fine tune the set-up and provide verification that it would deliver what was required. "We took into consideration Mean Time Between Failure and Mean Time To Repair and then mapped the flow of a part through the cell. So one improvement made was to put a buffer of parts on the robot carriage itself so that a part is available to be loaded once one has been unloaded from a machine," says Mr Masters.

The absolute minimum of labour was a key in the success of the cell because taking labour out negated low cost countries' advantage. Robots were the answer, but this was a key area of concern; Perkins wanted to be assured that this technology was robust and reliable. "It is the first time that Perkins, Peterborough, had employed robots and they wanted some confidence in this technology," explains Mr Masters. "We were able to demonstrate some facilities that Heller in the UK had delivered and underline that we could supply a turnkey project." The physical interface between robot and machine is critical, he observes, because that is where problems arise; so with the gripper and parts loading, for example – the Fanuc robots themselves can demonstrate above 99 per cent availability.

To avoid any problems in this area, heads are first block machined to provide consistent conditions for the robot, while there are air sensing and clamp force monitoring at the fixtures to detect any problems with loading. This is just part of the Poke Yoke (fool proofing/error reducing) strategy applied, in fact, that is applied elsewhere. For example, vision technology is employed to make sure valve

Production volumes are already exceeding the planned 85,000 – 100,000-plus is now touted

guides, seat and seal plugs are assembled correctly; gauges are colour coded to support easy, accurate selection and application; gauges are connected to the central quality control computer by Bluetooth not wires, which are a potential source of failure; cutting tool offset data is transferred to machines via Balluff chips, the data first having been transferred to these via a presetting station (again eliminating human error); spindle power monitoring is used to monitor tool life, while tool probing is used to check for the presence of drills after use.

NO UNTRIED TECHNOLOGY

Overall, though, while using advanced manufacturing solutions, the cell does not use any untried technology – Bluetooth is probably the most novel technological element, offers Mr Green, adding: "Our philosophy is not to be the first to try 'brand new' technology; we want to use proven techniques." Heller's proposals manager stresses that although the technology is not new, the application is – the mirrored design and built-in redundancy is itself the result of advanced production planning methods and simulation, while the controlling logic is also sophisticated. The fact that the two loading/unloading robots share the same track required writing some sophisticated software to guarantee their separation is also emphasised.

The manufacturing facility has been running 'in anger' since early this year. In fact, it is already operating at capacity with a move to four-shift, seven-day working likely to deliver the new 100,000-plus heads/year required; additional machines (two) can be added to lift capacity further.

In terms of performance, the facility has beaten both cost and quality goals. A quality level of Cpk 2 is being achieved on tolerances as tight as 25-50 microns – dowel centre to centre. Called Platinum level by Caterpillar/Perkins, this achievement is ahead of the corporate goal of Silver this year, Gold next and Platinum thereafter.

The quality requirement from the customer is 250 reject parts per million, with parts delivered straight to the assembly line. This is just below a Five Sigma level. Six Sigma, perfection, is 3.4 parts per million. But on quality, even a Japanese ISM engineer is quoted as saying that component quality surpassed not only that of the incumbent supplier, but also that of those produced in Japan.

As for OEE, the 85 per cent figure has also been surpassed, the best achievement so far being 91 per cent. According to Heller's Mr Masters: "This is brilliant. From an automated system, I wouldn't expect any better than that."

By way of comparison, another system featuring six non-Heller horizontal machining centres on a central backbone and machining a three-cylinder engine head design requires 27 operators across three shifts against the latest facility's nine. Output is also some 25 per cent lower for the older technology at 60,000 units/annum, while OEE for this set-up is 70-75 per cent.

Now a $50 million crankshaft machining line is being installed and a further project under discussion. But this is not romantic attachment to UK manufacturing, as Mr Green concludes: "We are able to offer a globally competitive solution. If we couldn't, parts would be sourced externally."□