

# The final piece

research centres

**Rolls-Royce has found the way to bridge the gap between university research and production – inspired by the Rotherham-based Advanced Manufacturing Research Centre. Andrew Allcock reports**

**T**he Advanced Manufacturing Research Centre (AMRC), Rotherham has established itself as probably the highest profile manufacturing process development facility in the UK over its short life (see box opposite page). But it has also become a key element within Rolls-Royce's growing worldwide research and development undertakings, as Dr Jamie McGourlay, partnership coordinator for Rolls-Royce at the AMRC explained at a recent event.

An AMRC partner for three years, the increasing importance that Rolls-Royce attaches to the facility is underlined by Dr McGourlay's and other Rolls-Royce personnel's increasing presence at AMRC,

plus the rebranding of the new, enlarged AMRC premises as the Rolls-Royce Factory of the Future. Initially, AMRC focused on metalcutting but has broadened its areas of research (see box again). The Rolls-Royce Factory of the Future (FoF) is now the home of the metalcutting activities, but it is also providing "the inspiration for Rolls-Royce to build a broader scale network of partners in key areas across our business in manufacturing", says Dr McGourlay, who explained the drivers behind the need for such an effort.

These business drivers for the firm include product challenges: high volume production of the US-led Joint Strike

Fighter programme, for example; new and novel components; new materials; new processes; and tighter specifications. Business challenges include: aggressive cost-down targets; improved process capability; reduced product introduction times; improved delivery adherence; escalating material costs; and a weakening dollar.

To meet all these challenges, the company needs new capability to remain competitive which means new manufacturing processes plus improved process understanding "at the fundamental level".

Dr McGourlay refers to the NASA-developed Manufacturing Capability

Readiness Level (MCRL) system to explain how the AMRC/FoF and other similar initiatives are to play their part in delivering this new capability. The MCRL plots manufacturing capability across nine levels – level 1 being the very earliest stage of technology assessment and proving, with level 9 world class production implementation.

Rolls-Royce has modified the MCRL system for its own needs, explains Dr McGourlay, “as an aid to understanding the process by which we identify a new technology or novel idea, graduate that technology up through the levels using a ‘gated process’ that allows us to rate the suitability of that technology to go forward to meet a business need, move it into pre-production and then into production at a world class standard”.

This is increasingly the system that the company applies to “anything we do in the area of manufacturing technology”, he explains.

So Rolls-Royce sees this approach as a way of mapping its own and its manufacturing technology supply chain partners, identifying where the gaps in capability exist. “We have a major

concern when it comes to MCRL levels 4 to 6. That is, when we have made the decision that we should invest in something through to maturity; where, how and with whom should we do that.” Levels 4 to 6 take in the late technology assessment/proving and pre-production stages. And that gap is between Rolls-Royce’s existing University Technology Centres – of which there are 27 globally – and manufacturing equipment suppliers, such as machine tool builders.

The AMRC/FoF fills this gap, demonstrating what Dr McGourlay describes as a new level of partnership, providing a ‘sandpit’ environment where manufacturing process testing and proving can be undertaken, and where it can be matured. So machine tool manufacturers such as Mori Seiki, MAG Cincinnati and StarragHeckert have supplied equipment on which new processes can be developed.

#### UNIQUE BENEFITS

Over three years, Rolls-Royce has seen the ‘unique benefits’ that the AMRC/FoF has delivered, which the partnership manager summarises as: a strong industry pull

from partners, especially manufacturing technology OEMs; the sharing of knowledge and best practice; demonstration of capability on real components on real machines; the availability of dimensional and material analysis on-site offering fast turnaround; co-location of engineers supporting knowledge transfer; ready formed consortium able to exploit public funding from bodies such as Engineering and Physical Sciences Research Council; the ability to try extreme ideas away from the constraints of production facilities; access to university expertise on process fundamentals; and access to equipment suppliers’ on-site experts, as well as latest machine technology.

But he also underlined specific benefits for Rolls-Royce over the past three years. At the beginning, the AMRC was given a blank sheet of paper to develop a next generation engine combustion casing manufacturing process. The Centre took 18 months over the project, but at the end demonstrated that it could make one equivalent in dimension and surface integrity to any currently in production, using a brand

## The Advanced Manufacturing Research Centre

The Advanced Manufacturing Research Centre (AMRC) is a £45 million partnership with Boeing that builds on the shared scientific excellence, expertise and technological innovation of Boeing and the world class research within the University of Sheffield’s faculty of engineering. It built on the original AMRC founded in 1999 by Professor of Mechanical Engineering, University of Sheffield, Keith Ridgway, and Sheffield businessman, Adrian Allen.

The AMRC with Boeing, opened in 2004 on Rotherham’s Advanced Manufacturing Park, received its initial government funding of £5.93 million from the Department of Trade and Industry. It received additional funding from the regional development agency, Yorkshire

Forward, and is also part funded by the European Union regional development fund, the University of Sheffield and, of course, the Boeing Company. It has partners which also contribute an annual fee – Tier 1 companies, such as Rolls-Royce, pay £200,000. Other partners include machine tool and cutting tool suppliers, for example.

Due to the success of AMRC with Boeing, it has moved into a new building to create “The University of Sheffield Factory of the Future with Boeing sponsored by Rolls-Royce” also called “The Rolls-Royce Factory of the Future”.

The vacated building will be taken, and expanded, by the Composites and Advance Materials Technology Centre (CAMTeC). It is focusing on low temperature cure composites and

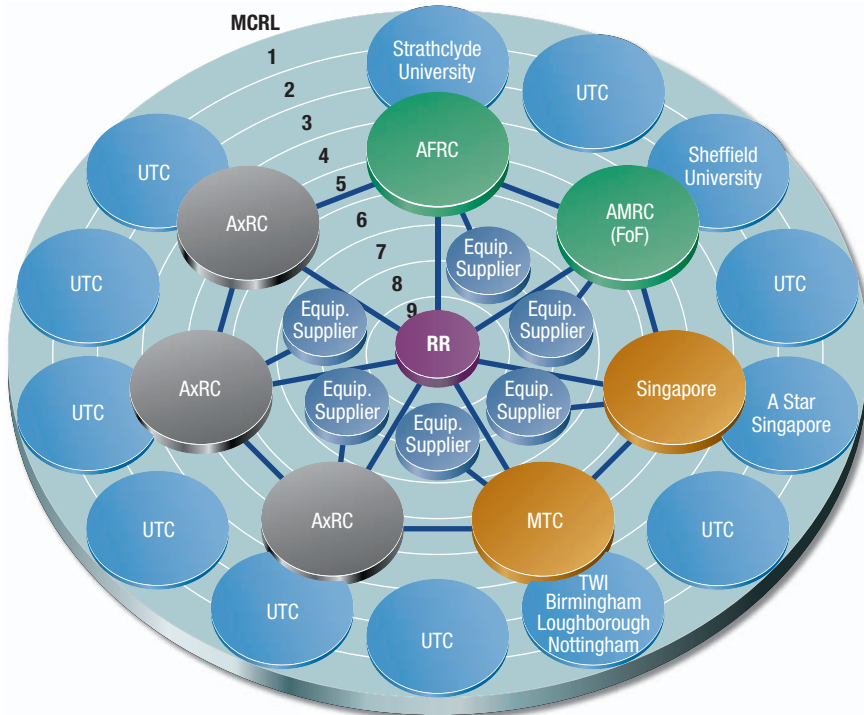
hybrid (composite/metal) structures.

Other activities located within AMRC are the IMPC (Innovative Metal Processing Centre), focusing on additive manufacturing techniques. The Centre Of Excellence in Customised Assembly (CECA), a collaboration between the universities of Loughborough, Nottingham and Sheffield, and backed by industry partners. It will be the machining and drilling node of the National Composites Network (see *Machinery*, April 2008, page 73).

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### A network that integrates Rolls-Royce partnerships



*Rolls-Royce and equipment suppliers work closely through MCRL7-9 although many of the equipment and tooling suppliers have significant research capabilities supporting MCRL 2 onwards (eg NCMT). The traditionally weak zone of MCRL 4-6 is now supported by the newly formed Manufacturing Research Centres (MRCs). Research institutes broadly occupy the MCRL 1-3 zone. A network is formed by creating partnerships to fill capability/maturity gaps and actively managing all of the key interfaces*

new material and a brand new forging process, and additionally demonstrating rough machining up to 20x faster and finish machining up to 8x faster.

Rolls-Royce was unable to take advantage of this in its current production facilities, but saw an opportunity to bring some of the elements into current projects which led to realisable improvements in cost reduction, lead time reduction in production, or to the production of demonstration parts that could be put into test engines to show next generation capability, Dr McGourlay explains.

"Today's range of projects sees AMRC/FoF working directly with our production facilities or with our [manufacturing technology] supply chain companies, showing how this knowledge, defined in those early stages, can be redeployed to reduce cost or lead times;

or define what practice will be used for next generation products," he adds.

Now, having bridged the MCRL gap in the machining area, and with the AMRC now also active in other areas, such as composites, the partnership co-ordinator says that Rolls-Royce must look across its whole "manufacturing process board" to identify areas where similar gaps exist and where a similar effort to that of the AMRC/FoF is required. For Rolls-Royce, this manufacturing process board includes casting, forming, joining, machining, finishing, coating, assembly, and repair – covering all its activities from "primary manufacture through to aftermarket activities".

So, explains Dr McGourlay: "We see the need to redeploy the AMRC model in each of these areas, whether that's extending the capability of the AMRC or building, funding or supporting new

research centres in the UK or around the world." And while he underlines manufacturing processes, he also highlights the importance of driving forward supporting technology such as non-destructive testing, measurement, CAD/CAM and tool design.

#### RESEARCH NETWORK

Rolls-Royce is therefore building a network of research centres to straddle the MCRL levels 4, 5 and 6 (see diagram). So, in addition to the AMRC/FoF, Dr McGourlay revealed Rolls-Royce's plans for its Advanced Forming Research Centre. This is to be established close to its Inchinnan facility in Scotland (see *Machinery*, 21 March, 2005, page 18). To be operational by mid-2009, this will be a new, purpose-built facility covering 3,000 m<sup>2</sup> that will focus on new forging techniques. The company is partnering with equipment suppliers here.

To be established in the Midlands on the Ansty Park, Coventry, the new, 15,000 m<sup>2</sup> Manufacturing Technology Centre has attracted £30 million of funding from regional development agencies Advantage West Midlands and the East Midlands Development Agency.

It will focus on high integrity welding and joining, fabrication, 'autonomation', fixturing and tooling and operational excellence, and the facility is expected to be operational at the beginning of 2010. It will work with University of Birmingham, Loughborough University, the University of Nottingham and TWI. Interest from Airbus, Goodrich and JCB is also reported.

Outside the UK, a new Precision Technology Research Centre is to be built, in Singapore focusing on surface modification development. The 500 m<sup>2</sup> lab and application space will be co-located with Rolls-Royce's production facilities in that country. And as the diagram clearly highlights there will be further research centres, or expansions to existing centres, to follow.

They are the final piece of the jigsaw, and the catalyst was Rotherham's AMRC. □