

# EMBRACING DISRUPTIVE TECHNOLOGIES IN MANUFACTURING

QUALITY WORLD SPEAKS TO EXPERTS IN THE ADVANCED MANUFACTURING FIELD TO UNDERSTAND THE LATEST INNOVATIONS, HOW THEY'RE BEING UTILISED BY INDUSTRY AND THE CHALLENGES GOING FORWARD

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## Advanced manufacturing research at the University of Sheffield:

The University of Sheffield has been named as the number one university in the UK for generating income and investment in engineering research by the Higher Education Statistics Agency (HESA). The University generated £124m for engineering research in 2017-18, working with a range of organisations around the world. Engineering research is delivered by the University's Advanced Manufacturing Research Centre (AMRC) and its Faculty of Engineering, with their research covering

sectors including manufacturing, aerospace, automotive and energy. The University recently unveiled three new multi-million-pound research centres, with the aim of boosting the region's reputation as a hub for advanced engineering and industrial digital technologies. The centres – the Royce Translational Centre (RTC), the Laboratory for Verification and Validation >



From the top: Professor John Haycock, Faculty Director of Research and Innovation and Dr Richard France, Senior Business Development Manager for Manufacturing Research in the Faculty of Engineering at the University of Sheffield.

(LVV), and the Integrated Civil and Infrastructure Research Centre (ICAIR) – were part-funded by the University of Sheffield, the European Regional Development Fund (ERDF) and UK Research and Innovation (UKRI), including funds received as part of the Henry Royce Institute and UK Collaboratorium for Research on Infrastructure in Cities (UKCRIC) programmes.

Quality World speaks to Professor John Haycock and Dr Richard France from the University, to find out how the three new research centres are providing a space for different industries to test their products and processes.

Professor John Haycock, Faculty Director of Research and Innovation for Engineering at the University of Sheffield, is responsible for setting strategy and prioritising research areas across the seven engineering departments. His role involves identifying funding opportunities from a variety of sources, for example the ERDF and UKRI. Dr Richard France, Senior Business Development Manager for Manufacturing Research in the Faculty of Engineering is responsible for helping academics obtain funding to carry out manufacturing research.

**QW: What are the biggest trends in advanced manufacturing?**

**Richard France:** One of the biggest trends now is the increasing use of digital technologies and data in advanced manufacturing, often referred to as Industry 4.0 or the Industrial Internet of Things. Manufacturers are collecting data about the products they make and processes they use, and creating digital twins of these, so that they can model and understand the processes and get them to work more effectively. UK government is supporting companies to implement these technologies via it's 'Made Smarter' initiative, with a pilot in the north west of England that is looking to help UK businesses adopt some of the technologies.

**QW: What are the challenges associated with digital data?**

**RF:** Some of the challenges are knowing what data to capture and how to get value out of the data. There are challenges around adoption, particularly for small and medium sized enterprises (SMEs) in terms of understanding how they can get digital to work for them.

Advanced manufacturing doesn't have to be expensive for companies and the AMRC's Factory 2050 has a great

demonstrator project showing how these technologies can be applied to legacy machines.

**QW: What problem did the three research centres at the University of Sheffield set out to solve?**

**John Haycock:** The centres address different areas. Broadly, they translate fundamental research in engineering and work with industry to solve problems with products or processes and the creation of new technologies. The RTC focuses on advanced metals processing, which aligns with materials and manufacturing challenges in aerospace and automotive industries. The Centre also looks at lightweight solutions for these industries by combining new materials and new methods for processing them to form engineering structures and components. Rolls-Royce, for example, have been able to progress their research and development of light weighting and new materials for engine components.

The LVV is a unique dynamics and acoustics research and testing facility that can recreate extreme environments across a range of test scales. A unique capability is a large (3m x 2m) multi-axis shake table incorporated within one of the environmental chambers. The facility is led by the Dynamics Research Group (DRG) based in the Department of Mechanical Engineering at the University, and offers benefits across a range of industrial sectors, including energy, aerospace, and automotive. The flexibility of the LVV enables testing of small-scale electrical components right the way through to complete structures such as cars, satellites and wind turbine blades. These tests determine whether the components are going to fail and predict component lifetime. It's not the sort of scale that one could conduct traditionally in a university, because it needs a large and dedicated space.

The ICAIR is focused on constructed infrastructure, including underground infrastructure. For example, the Centre looks at the extreme environments in water pipes in respect of life time and robustness. ICAIR contains what looks like a large swimming pool, where one can place pipe structures buried underneath several metres of soil, that would be carrying water. Then extreme tests are conducted by exposing the pipes to different external forces for field testing variables. As part of this, ICAIR is also developing technologies that use swarm robots to move along the pipes, using acoustic sensing and AI to detect failures. A signal would be sent to the surface so that a water company can repair failures before they spread across the network. Companies such as Yorkshire Water and Severn Trent can test these technologies before implementing them in their networks.

**QW: What type of other technologies are being implemented in the research centres?**

**JH:** The Centres have a lot of new equipment for scalable processes. The RTC is focused in terms of additive manufacturing, at taking things like metal (bar stock) to generate powders that, in turn, can be used for creating bespoke metal components.

They are also looking at things such as repeatability and reproducibility, for instance how reproducible the powder

forms are for repeated batch-to-batch manufacturing of structures and engineered components.

**RF:** Many current materials used in aerospace have come from traditional processes such as casting and forging and weren't designed for newer processes, so there is a real need to develop new materials. We have a vertically integrated research factory at the RTC. This allows us to create new materials at a small but appropriate scale, from a few kilograms to tens of kilograms. We then have the facilities to make small quantities of metal powder, which we can then test in new processes such as additive manufacturing. It would be expensive for an aerospace company to develop a new material, but RTC enables companies to de-risk that investment by doing some research and a small-scale feasibility tests. We can provide a broad range of additive manufacturing techniques, including powder bed and blown powder technologies.

**QW: How would you describe additive manufacturing?**

**RF:** Additive manufacturing, or 3D printing as it is more commonly known, covers a number of processes where materials are built up layer by layer. Initially developed for prototyping, this is now being used widely in manufacturing and offers a number of advantages over conventional manufacturing technologies, for example: greater design freedom and more efficient use of materials.

**QW: Richard, how has your background in quality management helped you in your current role?**

Images: Sheffield University/Stock



“ONE OF THE BIGGEST TRENDS NOW IS THE MOVE TO THE USE OF DIGITAL DATA IN ADVANCED MANUFACTURING”

**RF:** My previous experience in quality management involved developing new assays for testing drugs in the pharmaceutical industry, which would come under Good Manufacturing Practice (GMP). There are some parallels between the pharmaceutical industry's 'Quality by Design' approach and the approach we are taking to powder based processes in the RTC. In both cases, we are dealing with very variable starting materials and variable processes with limited monitoring, which lead to variable outcomes. Overcoming these challenges to achieve 'Right First Time' manufacturing is a key part of the EPSRC Future Manufacturing Hub in Manufacture using Advanced Powder Processes (MAPP), which we host at Sheffield.

**QW: What have you learned since the centres launched in October 2018?**

**JH:** We are keen to ensure that a lot of the fundamental research that's conducted in science and engineering, engages with industry. What we're seeing is the exchange of knowledge and it's happening at a time when there is a considerable demand for these types of translational centres. These essentially 'sit halfway' between the fundamental work of a university and the higher TRL (technology readiness level) work conducted by industry. The benefit for industry is that they can access these facilities and through partnerships, accelerate the development of their next-generation products.

**QW: What are the plans for the future?**

**JH:** We have a real appetite for further investments in knowledge exchange, innovation and translation. We are working on ensuring the success of the three centres by developing partnerships with both regional enterprises and large multinational organisations. Another priority is working on energy efficiency and clean energy technologies, which includes traditional fuel and carbon utilisation, energy storage, and nuclear energy.

**RF:** In the Faculty of Engineering, we have a range of manufacturing research activities. We are involved with UK-wide research centres across advanced powders, robotics and autonomous systems, electrical machines, semiconductors, photonics, metrology and pharmaceuticals. We're open to working with industry partners, to find out what their challenges are and how we can help. This could be through testing, consultancy work, collaborative research and development, leveraging funding from UK government or opportunities such as the Industrial Strategy Challenge Fund. ▶

Images from top to bottom: The Faculty of Engineering's world-leading translational research facilities: The Royce Translational Centre (RTC) has been set up to evolve novel materials and processing techniques developed by research teams and make them accessible for trial by industry.

“WE HAVE A REAL APPETITE FOR FURTHER INVESTMENTS IN KNOWLEDGE EXCHANGE, INNOVATION AND TRANSLATION”



## THE MICHIGAN MANUFACTURING TECHNOLOGY CENTER

The Michigan Manufacturing Technology Center is a not for profit business management consultancy assisting small to medium-sized manufacturing businesses in the state of Michigan, US. Quality Program Manager, Andy Nichols, helps companies to implement international quality standards, adopt other quality tools and with problem solving and layered process audits, and provides consulting and training in quality assurance and improvement.

We find out how he is using quality to help manufacturers improve their processes and the advantages of combining quality improvement with advanced manufacturing.

**QW:** How are you using quality to help small to medium-sized manufacturing companies in Michigan?

**Andy Nichols:** Many companies are not very rich on information; they don't know much about their processes and how to get consistent results. We are using quality to generate the information about why the process doesn't work as planned. That way, we can equip them with the tools to correct their issues and make improvements.

**QW:** When people see those process improvements, do they recognise the importance of applying quality assurance and quality standards in their business?

**AN:** Yes, absolutely. I recently worked with a small company that makes racing car radiators. They used to check the parts, and the parts were always good when they left, but they didn't know how many times they touched them to rework them or to fix issues while they were being assembled. When we started gathering the data, we found they could make much better decisions about where in the process something was causing them a problem, and this could, therefore, reduce their costs.

**QW:** What are the benefits of advanced manufacturing techniques for these companies?

**AN:** We are spearheading a programme here in the US to make Industry 4.0 initiatives much more accessible to small to medium-sized businesses. We have a manufacturing facility that we use to demonstrate a number of different aspects of Industry 4.0 and advanced manufacturing technology. One of the biggest responses we get when we show people these advances is that they are not as expensive to implement as they expected.

For example, putting sensors on equipment to drive the data analytics through the Internet of Things (IoT) will give management a better idea – in real time – about throughput rates and productivity – and how to get it right first time. Using robotics is also beneficial, as these machines are more consistent; they don't get fatigued, for example, and that impacts quality. With automation we are now focusing more, for example, on developing 'cobots' – machines which do what we call the 'three Ds' (dirty, dull or dangerous) type of jobs. Nobody wants to do those jobs, and they can be done best with a machine.

Image: Sheffield University

“WE ARE SPEARHEADING A PROGRAMME HERE IN THE US TO MAKE INDUSTRY 4.0 INITIATIVES MUCH MORE ACCESSIBLE TO SMALL TO MEDIUM-SIZED BUSINESSES”

## THE FUTURE OF JOBS REPORT 2018

The World Economic Forum

38%

of businesses expect to extend their workforce to new productivity-enhancing roles

41%

of employers are set to focus their reskilling provision on high-performing employees

54%

of companies said they intend to focus on reskilling employees in key roles which will be using relevant new technologies

33%

of employers say they would prioritise at-risk employees in roles expected to be most affected by technological disruption

**QW:** What do you think that the future looks like for quality management as part of this?

**AN:** Some people still have that of 19th century view of quality being more of an inspection function. Today, by having good process controls and keeping people's variability out of it, it begs the question: do you really need to do any inspection anymore? Certainly, that inspection can be automated. I do think that, in the future, the quality professionals' role is going to be more about customer service, and also have a role earlier on in the process – much more linked to planning – both at a strategic and tactical level.

**QW:** What challenges does advanced manufacturing present to quality professionals?

**AN:** As with anything, I think that where there's change, there's fear – whether that's the fear of potential job losses or the fear of the unknown. In my view, quality professionals should seek opportunities to take ownership of the right areas of the business where they can best impact problem avoidance. ■



Quality Program Manager, Andy Nichols, from the Michigan Manufacturing Technology Center (above)

## A CYBER SECURITY STRATEGY IS NEEDED

With the rise of advanced manufacturing, industry is becoming increasingly vulnerable to cyber security risks

One of the most complex risks for manufacturing and other businesses, today and looking to the future, is cyber security. According to the EY Global Information Security Survey 2018-19, the average cost to a business from a data breach in 2017 was £2.8m. However, the survey found 55 per cent of organisations do not make cyber risks protection part of their strategy. With a greater reliance on automated systems and data, advanced manufacturing brings increasing challenges in this area for quality professionals, who need to be aware of the threats and understand how to avoid and manage them.

Andy Nichols, Quality Program Manager at the Michigan Manufacturing Technology Center, agrees that manufacturers are not sufficiently worried about cyber risks. They urgently need to adapt cyber security measures – such as those described by ISO 27001 Information

Security Management and the US equivalent NIST 800-171, he says.

“Possibly part of the problem is that many people don't understand the need for cyber security; they claim that it's too expensive. In fact, even a simple attack can bring large costs to an organisation. I heard about a company that had their whole calibration database wiped out in a malicious attack. All the information was lost, and they didn't have backups. The cost of rebuilding that, so they can stay in production, is huge, in comparison with putting in the right firewall, and doing backups and other cyber security actions,” Nichols warns.

Quality professionals should become more involved in cyber security, he suggests, and for this they will need to acquire new skills and become more familiar with the risks. “The interface between quality professionals and IT professionals

has never been more in demand,” he says. A wide range of common cyber threats includes: botnets, distributed denial-of-service (DDoS), hacking, malware, pharming, phishing, ransomware, spam, spoofing, spyware, Trojan horses, viruses, wi-fi eavesdropping and worms. Despite all these risks, many organisations still lack appropriate security configurations, such as encryption and hashing of passwords, and many have weak network and database security systems or lack backups and a disaster recovery strategy.

Looking forward into the future, a report from Deloitte, *Predicting the future of Cyber Security in Finnish Manufacturing – Cyber Secure Manufacturing in 2021*, published in 2018, suggests investments in cyber security “need to be continuous not only because threats keep on evolving, but also to keep the competitors behind.” By focusing on the right areas, manufacturing companies can become resilient organisations that can quickly and proactively respond to new threats and attacks, says the report.

Image above: The Laboratory for Verification & Validation (LVV) is a unique facility enabling research into the Verification & Validation (V&V) of engineering models across test scales and in all environments.