University of Nottingham
Institute for Advanced Manufacturing

Institute for Advanced Manufacturing

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Introduction

The future prosperity of the UK will increasingly depend on maintaining a resilient and sustainable manufacturing sector based on sophisticated technologies, skill base and manufacturing infrastructure with the ability to produce a high variety of complex products faster, better and cheaper. Technological developments such as 3D printing and additive manufacturing, big data analytics, cyber-physical, intelligent and autonomous machines and systems, smart devices and the Internet of Things (IoT) combined with new materials and manufacturing technologies are providing new opportunities for developing future products and reconceptualising manufacturing enterprises and supply chains.

The Institute for Advanced Manufacturing (IfAM) is at the forefront of these technological developments by conducting world-leading research, providing a world-class education environment and delivering high impact manufacturing technology solutions to industry. Established in 2010 as a unique multidisciplinary research environment, we bring together critical mass and expertise from across the university, including its international campuses, to develop new manufacturing technologies, processes and systems. Our research cuts across a range of science, business and engineering disciplines and addresses critical manufacturing challenges in additive manufacturing, composites manufacturing, manufacturing informatics, human factors in manufacturing, industrial robotics, manufacturing systems design, materials processing, operations management, logistics and supply chain management.

We work in close partnership with our industrial partners and deliver innovative technologies and solutions to key strategic UK industrial sectors including aerospace and defence, automotive, consumer, food, healthcare and energy. We also address the UK industrial skills agenda by delivering world-class undergraduate and postgraduate programmes in manufacturing engineering, supplemented by a range of continuous professional development courses tailored to the specific needs and requirements of industry.

The new iconic Advanced Manufacturing Building was completed in 2017 with an investment from the University of Nottingham and the D2N2 Local Enterprise Partnership. The building is the largest academic manufacturing teaching and research facility in the UK and will allow us to further establish the Institute for Advanced Manufacturing as an internationally leading centre and partner of choice for industry. Its unique design and world-class infrastructure will also inspire new generations of students to enter the manufacturing engineering profession.

Professor Svetan Ratchev
Cripps Chair of Production Engineering
Director of the Institute for Advanced Manufacturing

Advanced manufacturing technology

In highly competitive global industries such as aerospace, defence, healthcare and energy, customers demand products that are stronger, lighter, more flexible, more cost-effective and deliver better performance.

Often, commercial pressures and financial constraints mean it is not possible for manufacturers to spend millions on equipment or to give their own R&D teams limitless time to develop new ideas. That's where a strategic partnership with the Institute for Advanced Manufacturing can provide significant benefits.

We offer a wide range of cost-effective services to UK and international industrial partners and other global research centres. These range from design concepts and simulation to developing new technologies and processes. We also develop new manufacturing techniques, providing long-term strategic thinking and tackling some of the most challenging engineering problems on the planet.

Areas of research include:

- intelligent automation and assembly
- machining and condition monitoring
- metalforming and materials processing
- micro-manufacturing and nano-manufacturing
- precision manufacturing
- manufacturing metrology
- digital manufacturing
- surface engineering and processes
- advanced robotics
- biomedical manufacturing

How we benefit industry

We work with hundreds of companies across the supply chain. A major collaborator is Rolls-Royce, which has set up two of its global University Technology Centres here at Nottingham. The UTC in Manufacturing Technology identifies, assesses and aids the delivery of new and emerging technologies to support the company's strategy. This includes tackling current manufacturing challenges as well as identifying areas for future research. The Institute for Advanced Manufacturing supports UK manufacturing through innovation and collaboration.

In collaboration with Airbus we have established an international research Hub dedicated to developing future technologies in assembly systems, tooling and fixturing. This will help the company develop more advanced, high quality and lower-cost aircraft wing structures. The Hub activities have led to further partnerships with BAE Systems and other major aerospace companies.

Our research in smart reconfigurable assembly systems and devices has attracted significant amount of research funding and has benefited major international companies including Philips, Bosch, Festo, Mikron and others.

BAE Systems, along with a number of other international companies, has benefited from our development of novel machining techniques, such as using water jets to mill complex shapes. Other technologies include the development of miniaturised machine tools and more efficient grinding techniques.

Postgraduate student looking at a 3D nose produced by a 3D bioprinter

Centre for Additive Manufacturing

Additive Manufacturing (also known as 3D printing) continues to evolve as a highly relevant technique for both industrial and research uses. The Centre for Additive Manufacturing (CfAM) at the University of Nottingham is internationally regarded as being at the forefront of this exciting and growing research field.

Based in the Advanced Manufacturing Building on Jubilee Campus and with more than 100 staff and PhD students, we hold a large portfolio of grants from EPSRC and others to support our work. Amongst significant others, the EPSRC grants that are led from the CfAM include: Enabling Next Generation Additive Manufacturing Programme Grant (£5.8 million), Future Additive Manufacturing Platform Grant (£1.8 million), Formulation for 3D printing: Creating a plug and play platform for a disruptive UK industry (£3.5 million) and Centre for Doctoral Training in Additive Manufacturing and 3D Printing (£4.6 million). Our research spans across both fundamental and applied research and we collaborate in a highly multidisciplinary manner both internally to the University of Nottingham (for example Pharmacy, Physics, Chemistry, Centre for Biomolecular Sciences) as well as externally (for example Lawrence Livermore National Labs (US)).

One of our prime research focusses is to go beyond using single materials (either polymer or metal) and instead deposit multiple materials – both functional and structural – in unison to engineer highly functional, durable and life-changing items such as prosthetic limbs, 3D printed electronics, complex pharmaceutical devices and advanced engineering components. The core research carried out within our centre is therefore focussed on investigating the underpinning processes, materials and computational methods for Additive Manufacturing, giving the potential to move beyond structural applications and create fully functional systems using Additive Manufacturing rather than passive individual components.

We work closely with business to translate technology through to commercial use and have set up our own consultancy company (**addedscientific.com**) to more fully engage with multiple industrial sectors. By working across both academic and commercial enterprises, new opportunities for increasing functionality and adding value to the technology have been created.

3D Printed conducted silver tracks

Composites manufacturing

Composites – two or more materials combined – are increasingly popular in manufacturing due to their high strength and stiffness-to-weight ratios, performance benefits and ability to form complex shapes, which saves on assembly costs.

The applications for such products are hugely varied, ranging from high-volume, low-cost parts for the automotive sector, through to specialised, high-performance components for aerospace and satellite manufacturers.

The challenge for many companies is to develop the right type of materials which will push performance and deliver a competitive advantage. More specific challenges include understanding manufacturing variables and their influence on components and reducing environmental impact.

The Institute for Advanced Manufacturing supports industry by developing new, economical processes to make composite components and structures, while ensuring they are more efficient and sustainable. We also offer access to specialist equipment that organisations may not otherwise have access to.

Over the past 30 years, our experts have earned a reputation for providing internationally recognised composite materials research across sectors such as automotive, aerospace, wind energy and healthcare. Current areas of research include:

- manufacturing process simulation and development
- multiscale modelling of textiles
- structural analyses
- end-of-life and recycling

How we benefit industry

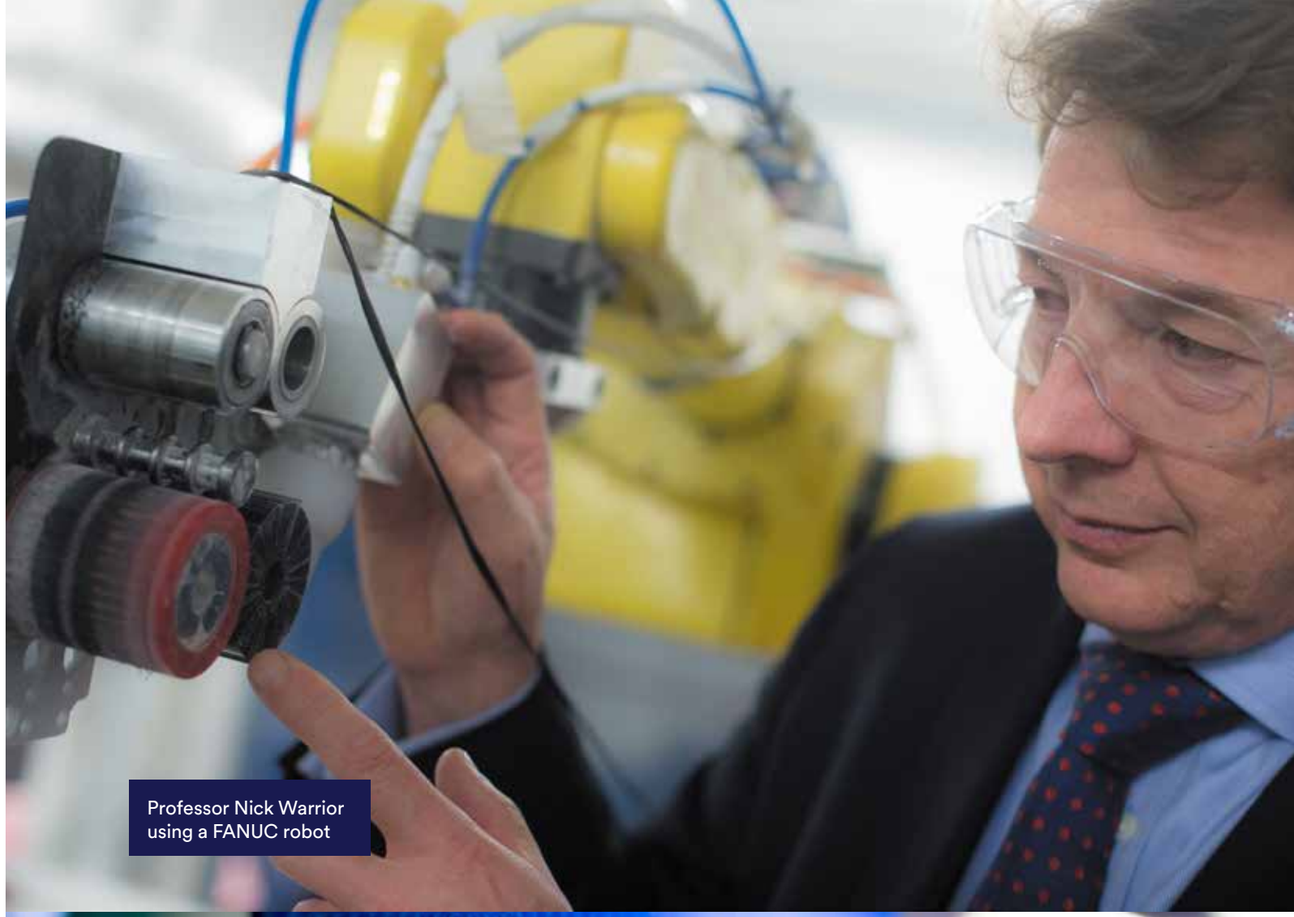
We work closely with a number of global organisations including Airbus, Boeing, BAE Systems, Rolls-Royce, GE Aviation, GKN, JLR, Aston Martin, Bentley and Hexcel. We also collaborate with a large number of SMEs who are able to cost-effectively tap into our expertise.

In particular, we have a long and successful history of working with the automotive sector. Our engineers have been instrumental in developing materials, modelling and processing techniques for a range of components including structural bodyshell elements and low-cost carbon fibre panels.

Our researchers also work closely with the aerospace sector, where advancements in optimisation techniques and high-deposition automated manufacturing aim to address the challenges in large scale production of high-performance structures. The technologies developed in any one sector are supportive or transferable to various other industrial applications.

The EPSRC Future Composites Manufacturing Research Hub

The EPSRC Future Composites Manufacturing Research Hub is led by the Universities of Nottingham and Bristol. The Hub, launched in January 2017, is a seven year project to accelerate the development of automated manufacturing technologies, coupled with the underpinning process science. The Hub aims to become the national centre of excellence in fundamental research for composites manufacturing, creating a pipeline of next-generation technologies to address future industrial needs and inform the national composites strategy.



Professor Nick Warrior using a FANUC robot

Composite research material

Rolls-Royce University Technology Centre in Manufacturing and On-Wing Technology

The Nottingham Rolls-Royce University Technology Centre in Manufacturing and On-Wing Technology (UTC) was established in 1999 as part of the Rolls-Royce UTC network. We are based in the University's Manufacturing Research Division, offering Rolls-Royce access to advanced world-class academic research in manufacturing aimed at specific industry needs. We work in three main interconnected research streams to support our industrial partners and manufacturing community: machining, fixturing and tooling, and robotics.

Advanced manufacturing processes

Our team specialises in advanced manufacturing technology such as conventional machining, waterjet milling/cutting, pulsed laser ablation, ultrasonic polishing, as well as in depth materials properties characterisation (SEM, XRD, EBSD, TEM, Raman Spectroscopy, micromechanics test) after machining.

Innovative fixturing and tooling

Fixtures and tools are critical when it comes to manufacturing items, as they form the bridge between the workpiece and the equipment that will perform the operation. Due to this importance, the UTC is currently researching a number of critical aspects related to jigs and fixtures, focusing both on fundamental research and the design of innovative solutions.

Robotics for in-situ repair

Robotic systems for in-situ repair is one of the research areas for the Machining and Condition Monitoring team. We focus on developing fundamentally novel, miniaturised robotic systems, for example, a walking hexapod and continuum robot for inspection, maintenance and repair operations in challenging environments such as aero-engines and nuclear reactors.

Flame spray adder for in-situ patch repair of aero-engine combustors (FLARE)

FLARE is a project utilising two continuum robots to navigate through the narrow inspection holes found in many aero-engines and collaborate together inside of the combustor for in-situ inspection and repair of coating delamination.

You can find more information about this project online at: **https://gtr.ukri.org/projects?ref=102360**

Two continuum robots carry out in-situ repair

Professor Dragos Axinte using a continuum robot for accessing confined spaces using a microwaterjet

Centre for Aerospace Manufacturing

The Centre for Aerospace Manufacturing (CAM) is an international research Hub with a mission to conduct translational industry-focussed research into future aerospace systems and the digital factory.

Established in 2010, we have rapidly expanded our project portfolio to a current level in excess of £10 million. This is built on our strong Engineering and Physical Sciences Research Council (EPSRC), Innovate UK, Aerospace Technology Institute (ATI – a collaboration between the UK government and aerospace industry), and European Union 'Clean Sky' and 'Factories of the Future' research record. Industrial partnerships now include Airbus Operations UK, Airbus Helicopters, BAE Systems, GE Aviation, GKN Aerospace, Leonardo Aerostructures, and SAFRAN Nacelles UK.

CAM has recently gained a new home in the Advanced Manufacturing Building (AMB) at the University of Nottingham. This facility provides the platform to develop, test, and demonstrate new research concepts and support their accelerated translation into future production technologies alongside our industrial partners.

Offering the full spectrum of capability, delivering solutions from early research to industrial application, we follow PRINCE2® project management practices and are accredited to ISO 9001:2015. This provides a unique academic research environment.

Our research initially focused on innovative tooling for aerospace assembly processes. This has evolved as CAM has grown and our five key areas of research are now:

- advanced tooling and fixturing
- aerostructures and design
- assembly processes and metrology
- automated systems and robotics
- digital factory

The University of Nottingham invested £1.2 million in a multi-function, final assembly cell to enable the demonstration of innovate processes and systems. Known as the Future Automated Aerospace Assembly Demonstrator (FA3D), the cell features modular recipe-driven process selection, RFID part identification, dual collaborative robots, automated conveyor systems, barrierless safety systems, and integrated vision systems to enable adaptive assembly processes. The cell has been used to demonstrate a variety of projects for industrial partners.

Building on the success of the FA3D, we have now secured £3.8 million funding from UK Research and Innovation's Industrial Strategy Challenge Fund. This funding is to set up a new demonstrator platform called the Future Automated Aerospace Assembly Demonstrator Phase 2 (FA3D2). This new platform will become a national experimental testbed and technology demonstrator in digital and informatics-enabled manufacturing. Aerospace companies are already benefitting from the FA3D, and the FA3D2 has been designed in collaboration with industry to address their needs. It provides a unique opportunity for such companies to test, demonstrate, and accelerate the application of breakthrough technologies in a highly flexible assembly environment.

Precision Manufacturing Centre

The Precision Manufacturing Centre (PMC) is an industry facing research centre specialising in high precision manufacturing technologies. We provide a testing and validation environment for world leading research and knowledge exchange in precision machining and metrology. We also provide a range of services to industry ranging from the development of new product designs and manufacturing techniques to pilot production of low-volume, high value products. To support the uptake of the new technologies we offer comprehensive specialist training and technical support.

Established in 2003, we have some of the most advanced high and ultra-precision manufacturing equipment in the world, managed by a team of expert engineers. We support the complete manufacturing lifecycle including digital engineering, component manufacture, high precision assembly and verification and inspection. Our capabilities allow us to manufacture a wide range of challenging products using different materials to an unprecedented level of precision. Our skilled technicians have many years' experience of working with our customers to design and deliver complete product solutions on time and to specification. All work is carried out under our ISO9001:2015 Quality Management System and managed according to PRINCE2® Project Management.

We have worked with businesses and provided knowledge and support services to critical industrial sectors:

- aerospace
- automotive
- biomedical
- defence
- energy
- medical
- micro-assembly
- consumer products
- nano-technology

We are always looking for new manufacturing challenges by expanding and applying our expertise in different industrial sectors.

Advanced Materials Research Group

The Advanced Materials Research Group (AMRG) specialises in innovative research focussed on providing solutions and expertise in fields spanning:

- biomaterials
- energy materials
- surfaces andinterfaces
- nanomaterials
- functionality and structure of materials
- photonics and processing

We have expertise in many processing methodologies such as microwave process engineering, hydrothermal synthesis, solution plasma spraying, reactive sputtering and laser/ electron beam surface modification.

Our research is leading the development of technologies in healthcare, such as addressing issues linked to the ageing population, solving problems in interfaces in wide range of applications from de-icing coatings to thermal barriers, utilising nano-materials such as in novel composites or body armour, as well as energy translation and storage from solid oxide fuel cells to hydrogen storage.

We are building a dynamic, interactive community in novel materials manufacture, processing and detailed micro and nano characterisation enhancing research excellence and impact. Our expertise covers all classes of materials and scale up production of many of the synthesis processes working with industry. We also prioritise developing and training highly qualified researchers; conducting internationally leading research in materials science and engineering and interacting with a range of stakeholders to ensure knowledge transfer.

Surfaces and interfaces

The Surface Engineering sub-group within AMRG has the expertise to address surface and interface issues from multi-disciplinary points, covering both fundamentals and engineering applications.

Our research objectives range from surface and interface design in atomic and molecular level, to film/coating fabrication for the functionalisation and protection of engineering components, as well as the related microstructural analysis and coating performance evaluation in aggressive environments.

We have the capabilities to provide surface/interface engineering solutions for various industrial sectors, such as aerospace, energy, automotive, and healthcare, to name a few. State-of-the-art facilities are available to meet our different requirements, including physical vapour deposition (PVD), chemical vapour deposition (CVD), thermal spraying, electrochemistry and wet-chemical process.

Biomaterials

Our Biomaterials sub-group within the AMRG has a strong research portfolio both in fundamental research and development of medical devices to improve human health. Our main focus has always been on developing novel advanced biomaterials and their processing and manufacturing routes. A key aspect of our researchers' work within the group is their interdisciplinary nature and close collaborations and interaction with other academic, clinical and industrial collaborators both nationally and internationally.

Current research interests span atomic scale characterisation of amorphous structures and development of novel biomaterials for regenerative device applications focussed on osteochondral and bone tissue repair. We have also established glass production labs and glass fibre (melt and preform derived) drawing capability and expertise. Our research is also focussed on biodegradable and synthetic polymer structures, porous materials, fully resorbable glasses, biocomposites reinforced using nanoparticulates and short and long fibres, bioceramics, bioactive and antimicrobial surfaces and degradable metals.

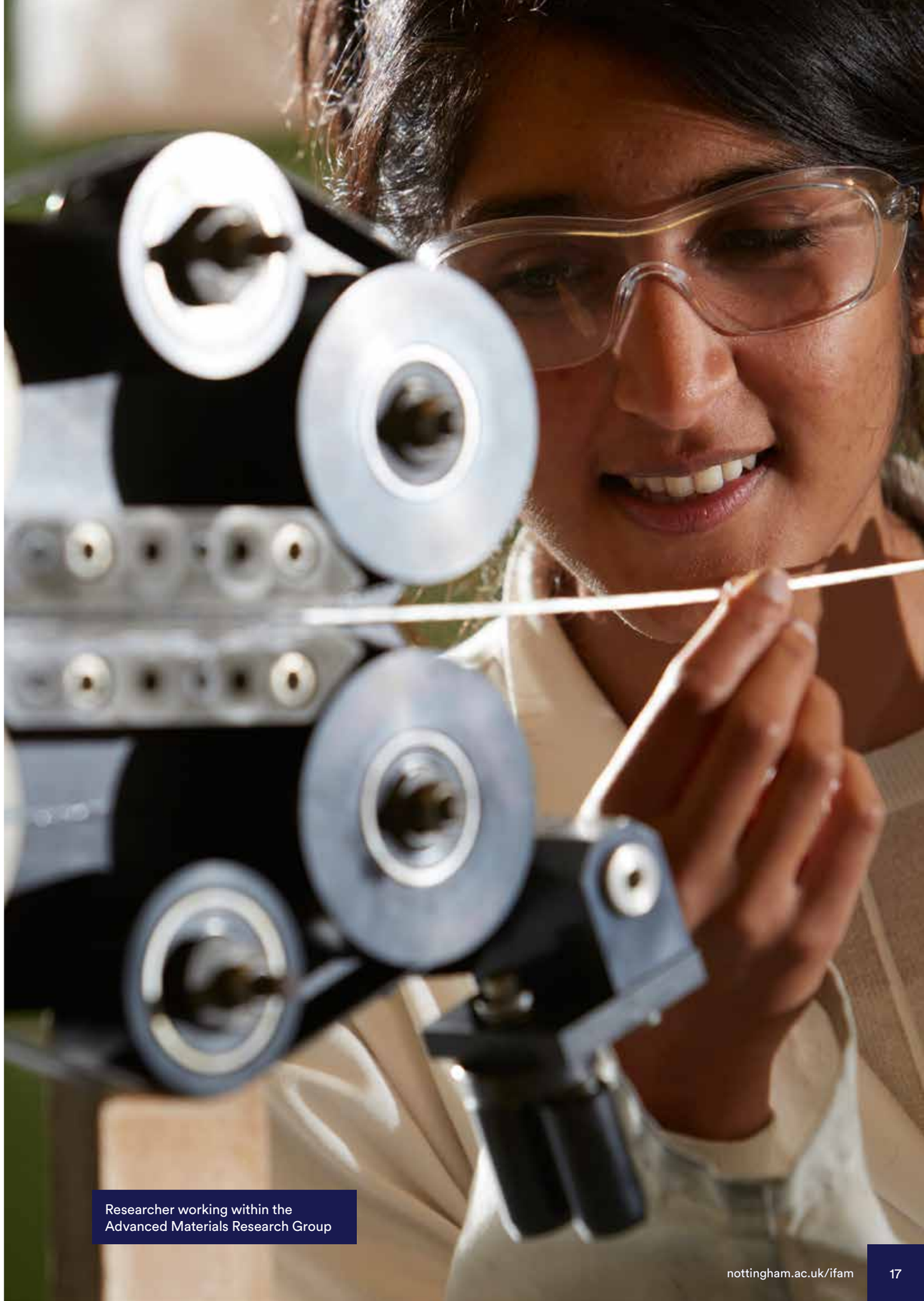
Energy materials

Renewable energy and energy storage are critical for a future sustainable world.

Here in the AMRG, we have expertise in many of these areas from hydrogen and thermal storage through to organic PVs to solid oxide fuel cells.

Microwave process engineering

Microwave process engineering is a multi-disciplinary research area that focusses on the development and commercialisation of electromagnetic technologies for materials processing applications, working across a wide range of industries including mining and minerals, energy, polymers and advanced materials, food and bio-products, to deliver technical, environmental and economic process benefits.



Researcher working within the Advanced Materials Research Group

Manufacturing informatics

Personal computers, the internet, wireless networks and mobile devices have transformed the way we live and work. As devices become cheaper and increasingly interconnected, digital technology is becoming increasingly embedded in all areas of our lives, from public spaces and buildings to kitchen appliances, furniture and even clothes.

This shift towards a world of ubiquitous computing and a convergence between the digital economy and traditional manufacturing opens up exciting and profitable areas of increasing interest to many companies. Our research into digital technology, and how it is designed and used in manufacturing, is crucial for helping those organisations to understand these new opportunities and for delivering economic and societal benefits.

Areas of research include:

- smart manufacturing systems
- the 'Internet of Things'
- ethics
- localised manufacturing

Manufacturing on your doorstep

Manufacturing is about the creation of products, which have to be stored and transported around a country or even the whole world. This can be costly, environmentally hazardous and difficult to manage.

Our researchers at the Institute for Advanced Manufacturing are looking at opportunities for creating smaller-scale, localised manufacturing. Thanks to advances in technology, companies may in the near future send their designs to local manufacturing plants who will make their products closer to consumers as and when they are needed. This could revolutionise the way consumers shop – making goods more readily available and greatly reducing the need for transportation.

How we benefit industry

Ubiquitous networks for connecting physical objects to digital environments, industrially accessible AI solutions, and high-performance computing form the building blocks for smart manufacturing systems. Smart manufacturing systems are a new class of "intelligent" manufacturing systems that can autonomously change configuration and behaviour throughout their life to maintain and continuously improve performance, in the face of product and process variations and fluctuations in demand. We have investigated the automated generation of process plans, allowing the cost-effective production of new highly-customised, complex products on demand, while simultaneously managing multiple product specifications and being able to self-adapt and self-repair to maintain optimum performance.

Smart manufacturing systems are closely related to the concept of cloud manufacturing (manufacturing-as-a-service). Setting up a manufacturing business is expensive, but greater digital connectivity allows businesses to design and make products using shared cloud-based resources, creating a much more fluid and cost-effective supply chain. We have investigated business models for cloud manufacturing, and how manufacturing resources can be safely and effectively advertised to the cloud.

As technology becomes more affordable, these digital services are creeping into everyday consumer products as well. With this technology manufacturers could, for example, monitor washing machine use, gaining a better understanding of energy use or predicting potential problems. This connected technology even in the most mundane objects could lead to a future that some call the 'Internet of Things'.

We are working in collaboration with Horizon Digital Economy Research, a research institute at the University of Nottingham funded by RCUK, which focuses on the role of 'always on, always with you' ubiquitous computing technology. Horizon investigates the technical developments needed if electronic information is to be controlled managed and harnessed to develop new products and services for societal benefit.

Obviously, such widespread monitoring creates legal and ethical debates around privacy, which is an important element of our researchers' work. Companies' understanding of this critical dimension is vital for their reputation.

SMART demonstrator in action in the Advanced Manufacturing Building

Healthcare manufacturing

The fascinating field of regenerative medicine could revolutionise healthcare. Combining stem cell treatment and tissue engineering with pharmaceutical therapies and surgical techniques, this research looks to develop new treatments for damaged, diseased or defective tissues.

The manufacturing of regenerative products is right at the cutting-edge of medical research; the materials being developed are composed of live cells and are extremely complex to make.

Our scientists at the Institute for Advanced Manufacturing are currently developing minimally invasive, injectable materials that stimulate a patient's own cell growth. This could help treat patients with a range of conditions, particularly in the area of orthopaedics.

How we benefit industry

Regenerative medicine is of great interest to pharmaceutical and biomaterials companies, yet there are many challenges to widespread use. Alongside material complexity, there are also issues around development costs and clinical trials, which can see a product take years to reach market.

The Institute's multidisciplinary approach, involving world class engineering, rapid prototyping and stem cell research, is well positioned to tackle these challenges. We are working closely with industry, clinicians and other leading universities in order to further develop the materials, technologies and manufacturing processes that could see regenerative medicine treat some of society's most serious health conditions.

The future of medicine

One example of where regenerative medicine could benefit patients is in hip surgery. Our researchers are developing material that could be injected into a patient's leg that would bond with cells and repair the damaged area. This could replace the need for invasive hip replacement surgery.

Researchers working in a Tissue Culture Laboratory

Food manufacturing

The availability of food is a growing concern for much of the world. Issues such as booming populations, climate change, water shortages and competition for land mean food security is a critical global issue.

Over half the world's food comes from just three crops: rice, wheat and maize. Possible solutions lie in the wider use of under-utilised crops, new crop varieties and parts of crops previously wasted.

Through research within the Future Food Beacon of Excellence, we are exploring how new crops can be converted for food.

Food science at the University has a long history of successful innovation and commercial partnerships. We have longstanding industrial relationships with some of the most prominent food manufacturers including Unilever, Pepsico, Mars, Nestlé, McCain and Mondelēz. These relationships have been strengthened in recent times with Nottingham leading the EPSRC Centre for Innovative Manufacturing in Food (2013-2019). We also work with a broad range of SMEs who can access state-of-the-art facilities at our Sutton Bonington campus. This rural setting is home to the School of Biosciences and the Future Foods Beacon, including a working farm and our Food Innovation Centre.

How we benefit industry

One area of interest to manufacturers is making the manufacturing process more efficient, using less water and energy, and cutting down on global transportation. The key lies in creating more concentrated products that can be 'made' at point of use. This requires a knowledge of the rules governing hydration, and also the effects that processing can have on the creation of the correct food microstructures.

In line with the Government's Industrial Strategy there is a need for the development of low-cost, nutritionally balanced, consumer-preferred products that are based on sustainable sources of materials. To achieve this valorisation of UK agricultural produce and food-process side-stream materials will be needed. In addition, there is a need for novel flexible and scalable manufacturing solutions that address consumer requirements for premium and personalised nutrition, and associated health benefits. Digital technologies will maximise labour and resource productivity for food processors and manufacturers.

We also work with companies to improve their processing. Increasingly, manufacturers are asked to produce many different lines of food products. Our researchers work with these companies on improving the way they process raw materials and in setting up flexible, efficient operations.

Understanding products and processes

Working with a major producer of potato crisps, we have been able to demonstrate how the company could recover by-products from their manufacturing processes. By understanding the structure-functionality of the material recovered successful inclusion in snack products has been achieved. This work demonstrated our researchers' ability to understand a food product, improve a manufacturer's processes and save waste.

Human factors

All manufacturing processes and systems, no matter how automated, interact with people as operatives, controllers, supervisors, planners and end users. Successful manufacturing, therefore, depends on human-centred design processes.

The human factors discipline provides the knowledge, tools, methods and developments needed to make the best use of capabilities, meet stakeholder needs and match the outcomes from manufacturing to the needs of end users.

Our human factors researchers conduct world-leading, interdisciplinary research into the behaviours and performance of people, user-centred design and systems design. We also provide leadership to national activities, bringing together multidisciplinary teams to understand how future digital manufacturing technologies can be most effectively designed and implemented. Our goal is to help manufacturing organisations understand human-systems interactions in order to improve their organisational systems, manufacturing processes and the end products.

Areas of research, include:

- design of tools to support implementation of future digital manufacturing technologies
- digital twins and advanced data analytics to support manufacturing decision making
- virtual and augmented reality for simulation and training
- transport systems engineering
- location aware technologies
- systems safety, security and risk assessment
- collaborative design, accessibility and inclusive technologies.

How we benefit industry

We work with a wide range of companies in sectors such as automotive manufacturing, aerospace and air traffic control, rail, medical devices and systems, virtual and interactive technologies, and construction. Key contributions that we make within these sectors are user needs and requirements analysis, system specification, testing and evaluation, organisational systems design and implementation support. Our industrial partners include Jaguar Land Rover, High Value Manufacturing Catapult, BAE Systems, Babcock International, Rail Safety and Standards Board, Nottingham University Hospitals Trust.

Our research highlights in support of manufacturing include:

- designing and evaluating technologies to support manufacturing operations design
- using visualisation technologies to understand passenger perceptions of aircraft interiors
- using virtual technologies to simulate and test automotive prototypes
- developing tools and techniques to evaluate work systems in transport control
- developing tools to understand functions and identify human factors risks in infrastructure work
- supporting the development of products for the elderly and people with special needs

Human-centred digital manufacturing

Working in collaboration from other colleagues within the University of Nottingham, UK academia, industry and policy makers, we provide leadership to the national agenda for digital manufacturing through the ‘Connected Everything’ EPSRC Network Plus. This initiative brings together over 200 participants to identify the key challenges we face as digital technologies transform our industrial systems and to support new collaborations between academics from diverse discipline areas to address these challenges.

We also lead a project funded by the Institute for Occupational Safety and Health (IOSH) to develop multisensory virtual environments for Occupational Safety and Health Training. This activity is delivering evidence-based guidance for the development and use of Virtual Environments (VEs) in engaging effective training using cost-effective and accessible solutions.

In 2018 we were awarded a £1.9 million EPSRC project to develop tools to enable industry to implement digital manufacturing technologies through the consideration of human requirements and technical capabilities. This project, which collaborates with the Universities of Cranfield, Loughborough and Bristol Robotics Laboratory will consider technologies including digital twins, robotics and physiological sensing to understand how multiple data sources can be combined to effectively support future digital manufacturing workplaces.

User in a driving simulator study, wearing eye tracking glasses to monitor visual behaviour

Operations management, logistics and supply chain management

Manufacturing is a global business. In the competitive global marketplace, manufacturing companies need to minimise design-to-market time, keep costs low, maintain high levels of quality, and deliver high levels of customer service.

The Institute for Advanced Manufacturing works with our team of researchers in the Operations Management and Information Systems Division at Nottingham University Business School to advise manufacturing businesses in all areas of operations management, improving the way they work and increasing productivity and profitability.

Areas of research include:

- operations and technology strategy
- systems design and lean techniques
- collaborative design and new product development
- supply chain design, logistics management, outsourcing and reshoring
- digitalisation and the digital supply chain
- planning, scheduling and control
- performance measurement and management
- quality management
- analysis, modelling, and simulation technology
- artificial intelligence for automating manufacturing processes

How we benefit industry

The Institute works with a number of organisations in the UK, Europe and Asia, including those in the aerospace, consumer goods, pharmaceutical and telecommunications sectors.

There is a particular focus on looking at how companies design products and the interrelations with manufacturing, supply chain and logistics. Our researchers explore the advantages and disadvantages of how and where teams are located, whether physically or virtually, across different disciplines and how they interact. An important aspect of this is so-called ‘concurrent engineering’, a systematic approach to integrate product design and manufacture that considers all elements of the product lifecycle from a very early stage. This can significantly reduce cost and time to market and is being increasingly used by major manufacturers.

We work closely with companies to assess their operations, helping them create tailored strategies that can lead to measurable improvements.

Effective order fulfilment in the automotive sector

Volume car producers face many challenges in delivering a very high number of variants, or buildable vehicle combinations, to the marketplace. We have worked with the automotive sector to develop analytical and simulation models to understand how best to match customers with appropriate vehicles from anywhere in the pipeline. Vehicles may be in dealership networks, in vehicle holding compounds, in assembly plants, or be ‘virtual vehicles’ planned for production.

Understanding how the number of variants offered affects the performance of these open pipeline fulfilment systems provides many new insights for effective systems design, management and control.

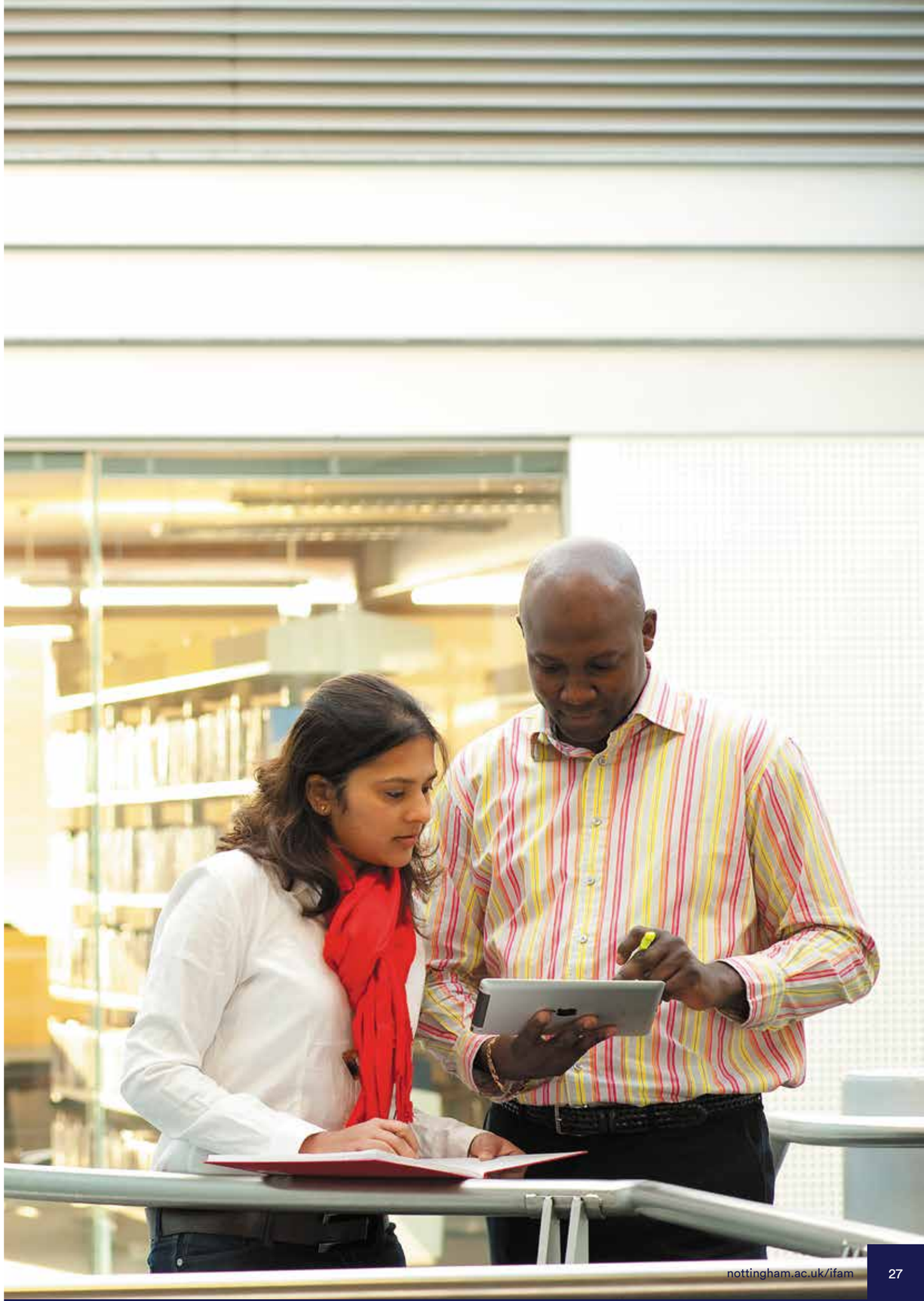
Analysing teamwork

A wide range of companies can improve the way they design and manufacture products through close collaboration with our academic consultants. One such example is one of Europe’s largest kitchen appliance manufacturers. The company wanted to experiment with co-locating multifunctional design teams in order to improve the development process and bring products to market more quickly. We were able to analyse how this worked, exploring the efficiencies and inefficiencies and make recommendations for improvements.

Supply network analysis

The manufacture of high value engineered products typically requires large scale and complex inbound supply networks. In sectors such as aerospace, machinery, and automotive, the inbound upstream supply network may be deep and lack visibility. Poor performance in one sub-tier supplier may affect the whole network and the ability of the OEM to deliver products on time to the level of quality required.

Our mapping and analysis of such supply networks requires advanced techniques to identify critical supply nodes. The methods we have developed allow such critical supply nodes to be highlighted and thus managed to ensure future supply.



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The University of Nottingham has made every effort to ensure that the information in this brochure was accurate when published. Please note, however, that the nature of this content means that it is subject to change, therefore consider it to be guiding rather than definitive.

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