Technology Strategy Board
Driving Innovation

Results of competition: Enhancing manufacturing through automation – Collaborative R&D

Total available funding for this competition was £9.3m from the Technology Strategy Board and EPSRC.

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
Aylesbury Automation Limited (lead) Sheffield Hallam University	Innovative composite end effectors for handling lightweight, flexible elastomers	£790,556	£504,099

Project description (provided by applicants)

This project will develop a range of innovative 'grippers' capable of handling high volumes of small, lightweight and flexible elastomer (rubber and synthetic rubber) products every second.

The automation opportunities developed through this project include automating the removal of elastomers from moulding lines; picking elastomers from moving conveyors; and rigid 'tools' into flexible elastomers. The successful development of 'grippers' to deal with these manufacturing challenges will also have wider applications.

Automating processes in high volume elastomer production environments can be complex because the moulded products often need to be removed from fast moving production lines/conveyors; air flows around the elastomer products can cause difficulties; and the products are highly flexible, and not uniform in shape.

We have a number of strong concepts for developing grippers capable of handling elastomers which will utilise a combination of innovative mechanical; electrical; and electro-mechanical techniques and enhanced visioning/sensing technologies.

Through this project we will develop and comparatively evaluate several proofs of concept for different gripping technologies. The most promising grippers will be selected for development and one or more grippers will be integrated in a prototype of a full automation machine.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Element Six Limited (lead) Oxford University (Dept. Engineering Science)	Integration of novel sensors for automating HPHT diamond processes	£667,746	£432,873

Project description (provided by applicants)

This industry-led, collaborative project will investigate new and existing remote-sensing technologies for application in High Pressure High Temperature (HPHT) diamond synthesis. To date, the challenge of extreme pressures (up to 15GPa), temperatures (up to 2000K) in the presence of molten metal catalysts in HPHT synthesis, have prevented the routine incorporation of real-time pressure sensing or even robust temperature sensing. As a result, current diamond production processes are effectively "flying blind". This lack of feedback control from the synthesis capsule severely limits automation.

During this three-year project, we hope to identify and develop robust or remote sensing technologies that are able to give real-time information about pressures and temperatures during the diamond synthesis process. The outputs from these sensors will then be used to increase automation in existing processes and also to enable development of robust predictive modelling, leading to increased efficiency throughout R&D and production.

Element Six (E6) is the lead partner and industrial end user whilst Oxford University will be providing the sensing expertise.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
European Thermodynamics Limited (lead) Jaguar Land Rover Limited Intrinsiq Materials Limited TWI Limited Queen Mary University of London Foundation	PRINTEG -Production Innovation for ThermoElectric Generators	£1,388,752	£1,084,560

Project description (provided by applicants)

The PrinTEG project builds on the previous development work of a UK-based consortium of SMEs and RTD partners who have developed cutting-edge thermo-electric silicide materials and automotive demonstrators that use these materials to generate electrical power from waste exhaust heat. The PrinTEG project aims to take this intellectual property and develop advanced automated manufacture and in-process sensing technologies to enable the low-cost, mass-manufacture of these thermo-electric generators. In so doing the consortium will maximise the chances that the manufacture of these technologies will be undertaken within the UK, rather than being lost to the Far-East, as has been the case with electronics manufacture over the last few decades. PrinTEG is a business-led consortium, with Jaguar Cars acting as the initial route to market for the technology.

The specific developments to be undertaken within the project relate to the development of:

- Automated powder handling and mechanical forming technologies for the creation of nano-structured thermo-electric material.
- Automated sintering technologies for the creation of net-shape thermo-electrics without the need for wasteful cutting and milling.
- Automated Pick + Place technologies for the handling and placement of the thermo-electric legs that are of complex shapes.
- Automated brazing and in-process sensing to optimise speed, quality and yield for the fabrication of thermo-electric generators.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Fully Distributed Systems Limited (lead) Centre for Engineering and Manufacturing Excellence Limited University of Warwick Ford Motor Company Limited Autodesk Limited Inotec Limited DBR & Associates Limited	Augmented Manufacturing Reality (AMReality)	£1,539,401	£790,960

Project description (provided by applicants)

This project focuses on the development of a novel augmented manufacturing reality, which will enable the automation of the design, configuration, re-configuration and use of manufacturing automation systems. The aim is to overlay and integrate digital data (e.g. CAD, Scans, video) and physical data acquired from sensors (e.g. power usage, temperature) into a virtual reality environment.

The main objectives of the project are to a) create a generic toolkit to enhance servicing and maintenance of automation systems, b) combine digital data and physical data to include feedback from the use phase into the design and simulation stages, c) optimise production efficiency and d) decrease set-up times and maintenance downtime.

The project consortium consists of a major end user (Ford Motor company), three innovative SMEs as technology providers for the virtual environment (FDS), distributed sensor integration (i.e. InotecUK) and specialist engineering knowledge (DBR Associates), a major technology provider of CAD and digital data systems (Autodesk) and two major research organisations with extensive experience in manufacturing research, automation systems and virtual reality (High Speed Sustainable Manufacturing Institute and WMG).

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Innovative Technology and Science Limited (lead) Computerised Information technology Limited Laser Cladding Technology Limited Brunel University	Automated in-line inspection and quality control of net shape powder metallurgy components using microfocus three-dimensional x-ray computed tomography imaging (Qualinet)	£1,250,359	£1,213,353

Project description (provided by applicants)

Net shape parts of typically intricate and complex shape obtained by powder metallurgy (PM) are employed in several key mass industry sectors, especially automotive, aerospace and medical. Their use is growing rapidly in preference to conventional casting because the process produces parts in the precise final shape required with little or no machining requirement combined with fine grained (nano-micro scale), homogeneous microstructures of enhanced strength. However there is a lack of production quality control as little in-line inspection is performed. End-of-line inspection, not often performed, leads to scrapping of 6-8% of components yet fails to detect micro-sized defects, which can grow in service to produce major in-service failures and recalls.

The project vision is an in-line quality control system (Qualinet) using 3D microfocus x-ray imaging (µXCT) with automation innovations (A) Detection and characterisation of volume and surface micro-scale defects at the pre and post sintering stages. (B) Decision making: (i) component acceptance or (ii) send for recycling or (iii) send with a prescription for defect healing treatment. Qualinet will eliminate waste, increasing line production, reducing energy consumption and carbon emissions, all by 8%. The benefit will be optimal for state of the art PM component lines including additive manufacturing by laser deposition, nano-powders and injection moulding. Estimated ROI comprising the profits of the partners, licensees and the savings in reduced waste from the PM systems on which the Qualinet sold system would be installed are 111:1 in the EEA and 35:1 over the first 5 years of commercialisation. Global acceptance of the net technology could save £340mpa.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Lightbody of Hamilton Limited (lead) University of Strathclyde Quasar Automation Limited	A smart and flexible automation system for high value cake manufacturing	£1,054,505	£988,831

Project description (provided by applicants)

The aim of the project is to investigate, research, and develop a new smart and flexible material handling automation system for cakes, their components and decorations. This system will comprise various sensors, software algorithms, and mechatronic hardware in order to create a more efficient and consistent autonomous production method. A major challenge within the project will be the creation of a novel handling and manipulation system that will be able to cope with the difficult attributes of the cake icing and decorative materials. These can be soft, sticky, brittle and floppy, all of these characteristics are very difficult for automated manipulator systems to handle.

The initial benefits of this project will be to (a) the cake manufacturing company in that the project will increase its efficiency, reduce its costs and increase its profitability, (b) the university in that it will expand its knowledge and expertise in this field, be able to provide knowledge exchange, and provide employment and experience for two researchers, and (c) provide the other UK industrial partner with an opportunity to enhance its experience and knowledge while contributing its existing expertise to the success of the task.

Further benefits to UK industry in general will result from the knowledge gained from the design of the system to manipulate the difficult-to-handle materials. This knowledge should have general applicability not only in the food industry but also in areas such as clothing manufacture. The developed system will be modular such that elements of the design, e.g. hardware, software, and sensing, will be useable by a range of companies.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Loxham Precision Limited (lead) Qioptiq Limited Hexagon Metrology Limited Aerotech UK Limited	Automation for mass production of high performance optics	£646,875	£359,000
Project description (provided by applicants)			
This project will devise and verify new automated manufacturing technologies that will enable effective mass production of high-end (high performance) optics. The project will realise new UK-designed and built automated manufacturing technologies appropriate for defence and commercial sector optics. Today, leading companies producing high-end optics employ very precise machines which are manually loaded/unloaded and have separate post-production inspection requiring manual operation. This project will develop and verify new automation methods that are functional for delicate optical workpieces and integrate a new in-situ measurement technique that can improve production rate and yield. The project will advance research outputs of a previous research council funded project (which created a highly novel compact machine concept) and apply to that concept new automation techniques for loading/unloading and in-situ measurement appropriate for both infrared and visible optics. This type of automation has previously not been applied. Today, demand for reduced size optics is common, and production batch sizes are increasing. These two factors raise the importance of automation. Significantly, the load/unload times are becoming a greater % of overall cycle times in optics production. The project partners include the UK's leading optical systems manufacturer and a spin-out company from the UK's leading Precision Engineering research institute.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Mondelez UK R&D Limited (lead) The Manufacturing Technology Centre Limited	INFINIte varieTY in confectionary manufacturing using new automation technology (INFINITY)	£989,043	£637,812
Project description (provided by applicants)			
It is currently impossible to precisely control the deposition of inclusions (typically nuts, raisins etc.) in moulded chocolate products at large commercial scales. Inclusions are very difficult to handle and they are currently mixed with chocolate prior to dispensing. This approach significantly limits the precision of metering and placement of the inclusions. Separating chocolate from inclusions represents a significant step forwards, providing higher accuracy and flexibility. To achieve this requires a new method of handling the inclusions. In the INFINITY project a comprehensive approach based on advanced automation, in-process sensing and simulation will be used to perfect the handling system. The new system will enable Mondelez International to manufacture chocolate products (with inclusions) with infinite flexibility at large commercial scales. No other chocolate manufacturer is currently able to achieve this. Moreover, the approach can be applied to a wide range of other food products, such as biscuits, and provides a new benchmark for inclusions handing within in the wider food sector. The project will be led by Mondelez International's Global R&D Centre in Bournville. The development of the new system will unlock significant investment in new equipment sourced from UK suppliers, helping to secure the future of the UK in terms of both process and product development in this highly competitive sector.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Pragmatic Printing Limited (lead) Optek Limited Centre for Process Innovation Limited University of Cambridge Henkel Limited	AUTOFLEX - Automated Integration of Flexible Electronics	£1,085,539	£979,696
Project description (provided by applicants)			
Printed electronics built on plastic and other cheap substrates (paper/card) can enable new products in high-volume markets such as consumer packaging and anti-counterfeit labels. The printed electronics market is estimated to be £1.5bn today, growing to £30bn by 2021 and £200bn by 2027 (IDTechEx). Conventional electronics on PCBs are rigid, difficult to distribute within products and over-engineered, resulting in high cost for these applications. Flexible (printed) electronics can overcome these constraints and enable many new ultrathin form-factor products. Highly-automated manufacturing processes are required to meet the extremely high volumes of these applications and integrate the thin-film components which will provide the required power, display/lighting, logic and other printed circuitry. Existing integration solutions such as pick-and-place (already widely used in electronics) do not cost-effectively scale to the very-high volumes required by consumer packaging and security products (ultimately >1trn units pa). This project will develop the automated manufacturing processes and system design based on laser-processing and low-temperature conductive attach. The project will open-up these high-value applications, in addition to providing lower-cost and improved form-factor for already addressable applications.			

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
R U Robots Limited (lead) Marks and Spencer Public Limited Company University of Lincoln Bakkovar Limited Proseal UK Limited	Food Industry Laser Mediated Sealing (FILMS)	£686,085	£276,694
Project description (provided by applicants)			
The FILMS project aims to improve the sealing of ready-made meals, particularly chilled foods through the use of laser sealing technology. This approach replaces existing heat sealing approaches and offers both greater flexibility and much lower energy costs. However, of more significance to the end customer is that the process will deliver more securely sealed food packs (less premature food wastage) while also providing a consistent peelability. The project partners are Marks and Spencer, Proseal, R U Robots and the University of Lincoln.			

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Dairy Crest (lead) SBBM Prosig Ltd Britpip Limited Datum Electronic Limited University of Portsmouth University of Nottingham	The virtual engineer - maintenance and operational management program for future food packaging	£1,179,704	£650,281

Project description (provided by applicants)

Milk is a common product found in nearly every household in the UK. Over 13 billion litres of it is bottled every year and the majority of it is purchased by the large supermarkets. Stork is a company which designs, manufactures and maintains milk filling machines worth over a million pounds. An individual breakdown can cost dairies over £50,000 which includes labour and parts for repairs but also lost production of milk.

This consortium will develop a prototype to analyse the milk-filling machines for any early fault signs so that any maintenance work needed can be undertaken during scheduled hours. In addition, it will provide detailed recommendations of actions to be taken and automatically order spare parts so the machines can be repaired with the minimum of fuss.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Tata Steel UK Limited (lead) TDL Sensors Limited	Improving premium steel manufacturing through automation	£638,589	£349,283
Project description (provided by applicants)			
Tata Steel Speciality is the only UK manufacturer of high value speciality engineering steels for applications such as critical aerospace and the automotive market. Production is very energy intensive and via batch process, of which the analysis step contributes a significant amount to the batch time. Each batch is usually different and for premium grades the control and reduction of impurities is critical. Automation and closed loop control of the process would offer significant productivity, energy reduction and sustainability benefits. While laser instruments, such as those designed and built by TDL Sensors Ltd, already enable accurate and fast measurements in the process industries, the challenge in the steel industry is the hostile environment; it is hot, dusty and under vacuum. Existing analysis instruments often use sampling systems to reduce the temperature, dust load and any contaminants thus adding a time delay to measurement. This project seeks to develop, install and validate in-situ laser-based instrumentation to monitor in close proximity to the molten steel batch reactor and use this to close the control loop to significantly reduce the batch times. A second element is a feasibility study on the practicality of using a laser to accurately measure the molten steel temperature.			

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Ultra precision Motion Limited (lead) MG Motor UK Ltd Pascoe Engineering (Barhead) Limited University of Birmingham University of Strathclyde The Manufacturing Technology Centre Limited	Automated manufacturing process integrated with intelligent tooling systems (AUTOMAN)	£1,988,667	£1,860,911
Project description (provided by applicants)			
AUTOMAN will develop and demonstrate advanced manufacturing processes and novel systems deploying intelligent automation technologies - digitally re-configurable tooling, robotic manipulators integrated with computer vision and artificial intelligence simulation software. The new systems will be for producing high-quality customised 3D functional and complex structural parts of lightweight vehicle body panels, high-performance building cladding facades and large integral components. Through the use of intelligent robotic machinery, the proposed automated manufacturing approach will enable rapid fabrication and flexible processing of large compound or freeform customised components in new advanced metallic alloys and hybrid reinforced composites for cross-sector applications - in short, Lean, Agile and Adaptive manufacturing. Industrial sectors benefitting from this work will include the automotive, aerospace, railways, marine, energy, construction, materials processing and tooling industries.			

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Zeeko Limited (lead) Glyndwr University	Developing an integrated system to enable a robot arm to speak with a Zeeko machine to automate currently manual operations.	£899,186	£592,000

Project description (provided by applicants)

We think so often of the materials from which things are made - wood, metal, plastic etc. Frequently, however, the real function of a material, beyond its internal strength, comes from the quality of its surfaces. This is the case where materials 'rub' (gears, bearings, knee and hip joint-implants, etc), reflect or transmit light (lenses, mirrors etc), manage fluid-flow (turbine-blades, propellers etc) and control the microscopic passage of electrical charge (silicon chips, etc). So, we see surfaces of all shapes and sizes are of fundamental importance to an enormous range of science, medicine, industry and defence. As the market become ever more demanding, there is a common drive for superior quality of surfaces, combined with faster manufacture at lower cost. This can no longer be addressed by incremental advances - a new way of looking at the problem is required.

Historically, research has focussed on specific processes. Now the tide has turned, and a new vision is required in terms of automation. This project looks at how this can be achieved in practice, in the context of Zeeko's computer-controlled polishing machines, and industrial robots from Fanuc Robotics. The over-riding objective is to bring to market manufacturing solutions that are "Better, Faster, Cheaper".