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AMRC Design & Prototyping Group

Capability directory

CATAPULT
High Value Manufacturing

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The AMRC Design & Prototyping Group undertakes high-risk research to develop novel products, machinery and equipment to help UK manufacturers deliver the next generation of innovative, high-value offering.

The Design & Prototyping Group is the winner of the UK Space Propulsion Innovation Award in 2015 and home to the world's first fused deposition modelled (FDM) ABS flying wing.

Our facility at the AMRC acts as a sand box for collaboration and innovation between industry and academic partners. Taking ownership of high-value projects and developments, we provide our customers with everything from concept designs and working drawings, to fully functional pre-production prototypes or research instrumentation.

Our team of multidisciplinary design engineers have a passion for creating innovative design solutions. As a centre of excellence in engineering design, we have provided autonomous delivery devices, precision drilling machinery and composite-forming machinery.

We are currently developing the world's first large-volume high speed sintering machine. The machine will be capable of building parts up to three times larger and 100 times faster than current additive manufacturing machines. Ready for spring 2017, the machine has the potential to challenge conventional injection moulding for high volume production.

By developing designs to meet the requirements of the manufacturing process, we can offer significant cost and weight savings, creating opportunities that enable our customers to keep their competitive edge.

For example, by optimising the designs for additive manufacturing processes the team managed to reduce the build time of the ABS flying wing by 85 per cent. The team have also improved process performance and functionality with our confined space drill, which allows for the previously impossible drilling of composite stacks in confined spaces, by the novel application of a miniaturised gearbox.

We adopt a collaborative approach to delivering projects, ensuring our knowledge is shared with you to build upon the success of the project after completion.

For more information, contact:

Craig Roberts,
Head of Design & Prototyping Group
c.roberts@amrc.co.uk

The AMRC Design & Prototyping Group can bring a wide range of capabilities and expertise to our industrial partners.

Technical capabilities

Our technology teams develop the techniques and underpinning science that can deliver significant improvements in engineering performance, including:

Click page to jump

To put this expertise into practice, we work with an array of state-of-the-art technologies located in the Design Prototyping and Testing Centre.

We have a wide variety of available technologies, many of which are optimised for specific prototyping applications. Our resources are available for collaborative research and development projects, giving companies the capability to develop innovative and optimised engineering solutions.

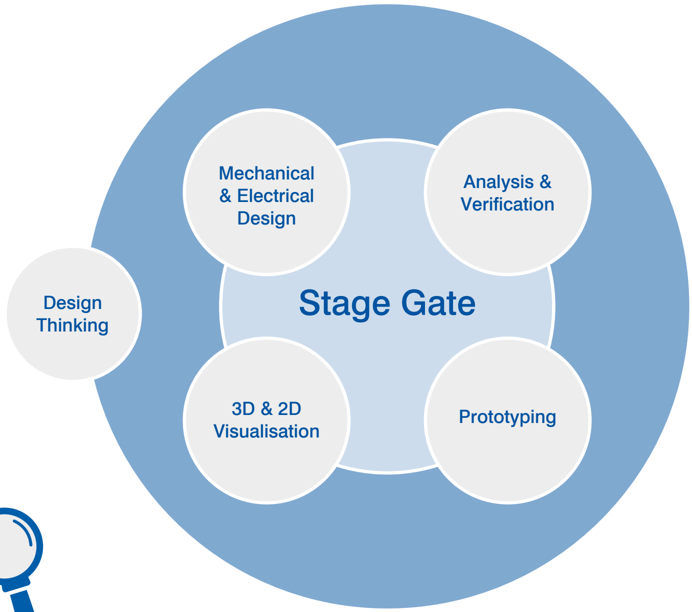
The following pages introduce the capabilities, core research areas and resources of the design and prototyping teams.

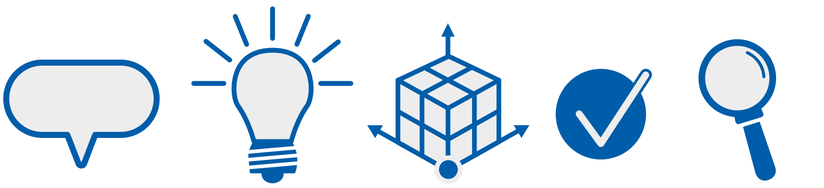
Stage Gate Product Development

The Design & Prototyping Group has created a five stage design and development process, moving from Initiation and Concept Generation, through to Detailed Design, Validation and Lessons Learnt.

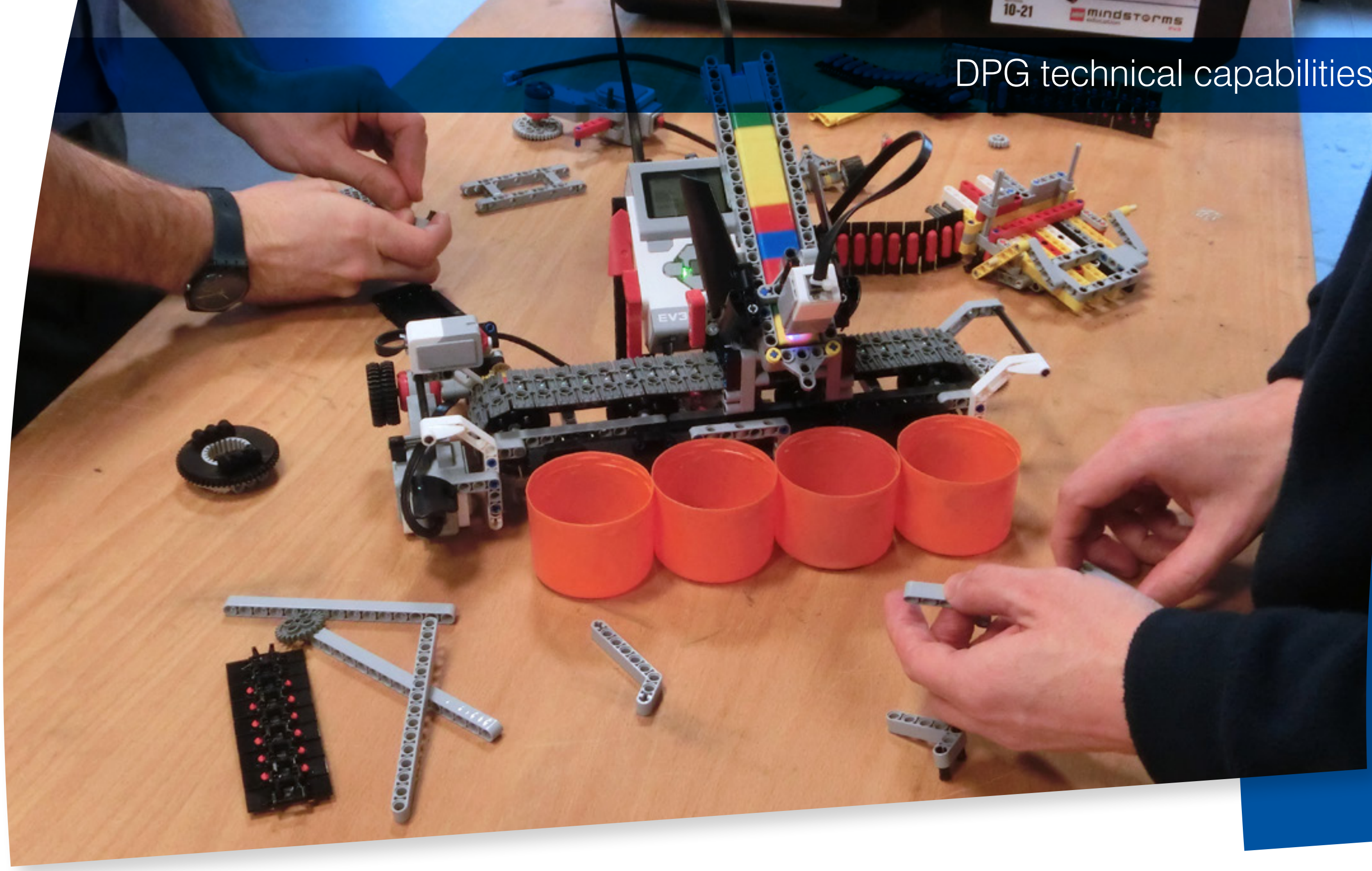
The brief is defined and set during Initiation, initial ideas are explored during Concept Generation, after which the chosen design is developed in the Detailed Design stage. Prototyping and testing takes place at the Validation Stage and the final, critical stage, Lessons Learnt, ensures our future projects benefit from the outcomes of past projects.

Each stage of the process is supported and monitored by using activity checklists. As no two projects are the same, we select from a wide range of tools and techniques to develop a bespoke approach for each project.





Initiation Concept Design Validation Learnings



Design Thinking

The Design & Prototyping Group applies the latest research to the design process to create a hybrid design methodology, called Storyboard Design. The technique allows designers to overcome critical issues faced in new product development, which include:

- Avoiding fear of judgement.
- Cognitive Inertia- where familiar assumptions aren't challenged.
- Production Blocking – the tendency for one individual's ideas to dominate during a group discussion.
- Social Loafing – where some people working in a group put in less effort than if they were working on their own.

The process also takes account of the availability of equipment to produce low cost prototypes in the early phases of the design, reducing the likelihood of 'sunk cost thinking' where investment in what has already been done influences future decisions.

Storyboard design is a fast, clean and efficient way of producing a number of unique ideas that can be incorporated in complete product designs.

Design for Additive Manufacturing

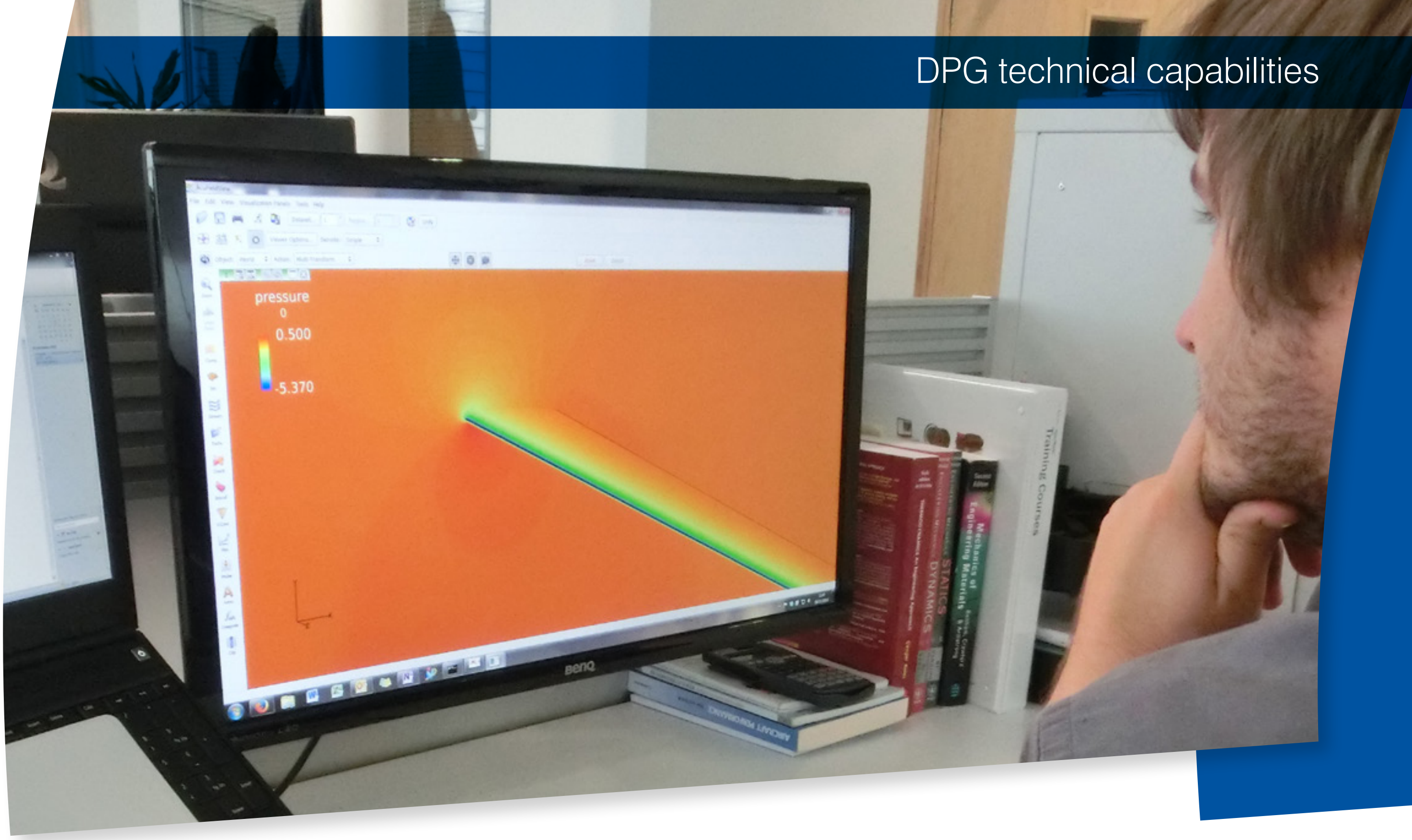
The Additive Manufacturing (AM) process allows complex design geometries to be produced in polymers and metals.

Additive Manufacturing has been seen as a slow, expensive process that produces components that have uncommon characteristics, and are limited to a single material.

Neither the AM systems, nor the supporting design tools, are mature and some designers' thinking hasn't adapted to the possibilities of AM technology.

We are swiftly addressing these issues by:

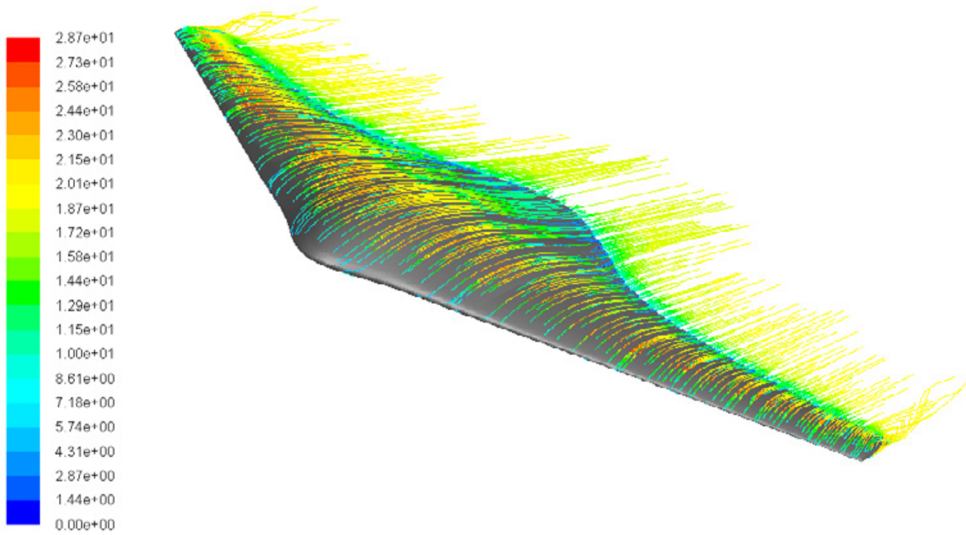
- Working with additive processes.
- Becoming specialists in the application of the polymer fused deposition modelling (FDM) technique.
- Pushing the capability of machinery.
- Bridging gaps in AM knowledge.

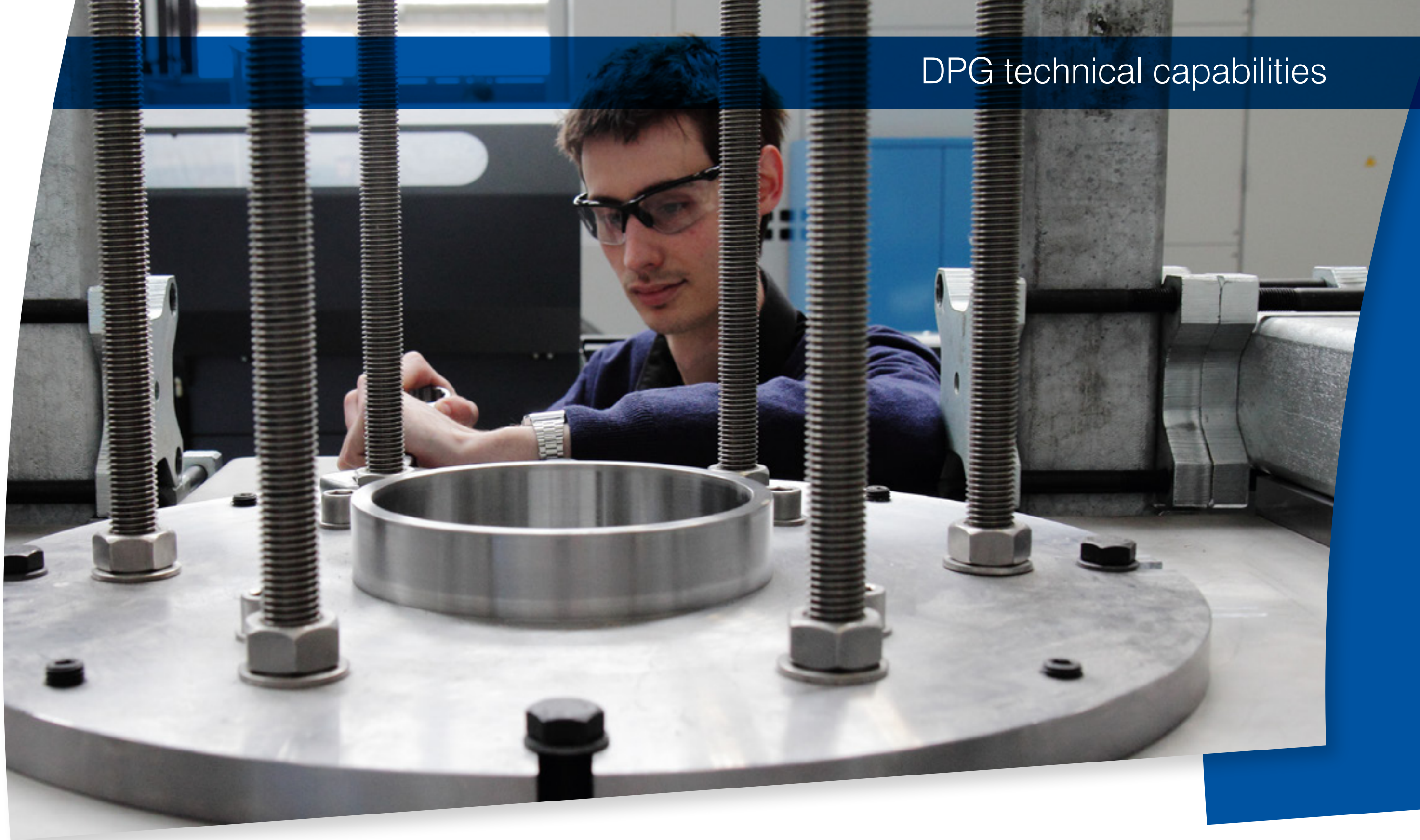


Analysis

Our Finite Element Analysis and Computational Fluid Dynamics tools allow us to undertake a variety of analytical tasks. We have the capability to develop and validate analyses for many structural, fluid flow and thermal design questions.

Our HyperWorks software suite allows us to create goal driven optimisation studies using tools such as shape morphing or topology optimisation. These tools can create designs which mimic biological organisms, such as dragonfly wings, bird bones and other organic structures.

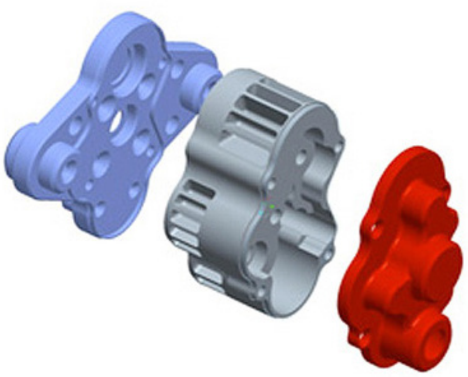


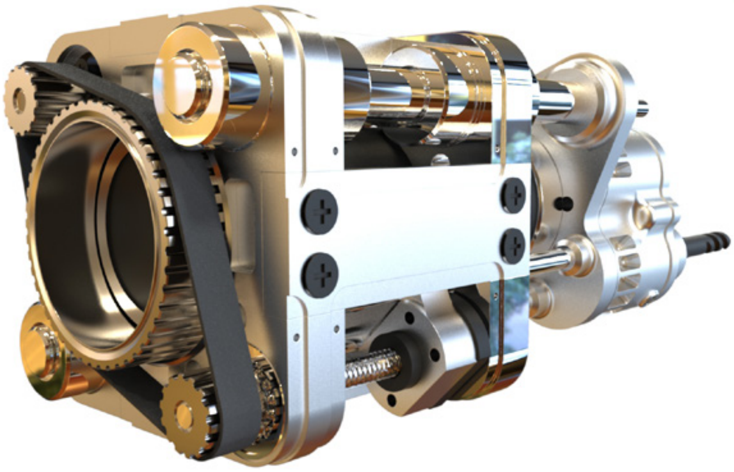


Mechanical Design

The Design & Prototyping Group has a broad range of engineering expertise, including expertise in the road, rail, heavy industry and product design fields.

This allows our team to respond to a variety of project requirements with confidence. In house developments have included our globally recognised 3D printed Unmanned Aerial Vehicle (UAV), a complex two speed miniature gearbox and a high precision residual stress drill.





Electrical Design

The electronics team has the experience to develop solutions from "proof of concept" through to "manufacturing ready prototype" in a way that is aligned to your manufacturing and testing methods and the core functional requirements. A robust methodology within a Stage Gate development process is used to deliver a high value design service at minimum risk.

Capabilities range from rapid proof of concept investigations using commercial, off the shelf hardware and Intellectual Property re-use through to detailed custom Field-Programmable Gate Array/Printed Circuit Board (FPGA/PCB) level design with associated embedded software. The design methodology is complemented by a range of state of the art software applications which enable effective management of multiple design constraints, pre/post layout simulation, and rigorous validation.

Problem Statement › **Proof of Concept** › **Custom Design** › **Manufacturing Ready Prototype**

Medical AMRC

The Medical AMRC is building upon the proven successful AMRC model applied to aerospace and high value manufacturing improvements, and focusing this approach to the healthcare industries. The group aims to improve and bring new manufacturing and materials technologies to healthcare and medical device companies through innovative design.

The team includes experienced engineers, product designers, software specialists, and material scientists from a wide range of industrial and academic backgrounds, with experience of solving problems through engineering design and product development.

The Medical AMRC has close links to research from the University of Sheffield's engineering and healthcare departments, teaching hospitals and clinical resources, as well as drawing on the expertise and resource across the AMRC.

The Medical AMRC's CT Scanner, Metal Additive machine and Cleanroom is based within the Design, Prototyping & Testing Centre workshop, which has a range of advanced machine tools and additive manufacturing facilities which complement possible medical device manufacturing requirements, further supplemented with the wider AMRC's available technology.

With Additive Manufacturing in mind, the Medical AMRC are using new design approaches to create innovative implants and improve manufacturing capabilities using state-of-the-art additive layer manufacturing technologies in metals and polymers. They also aim to explore how design could be used to reduce production time and costs, as well as to improve part performance, to add value to the manufacturing industry.

In combination with computerised tomography (CT Scanning), the Medical AMRC is researching the optimal way of designing for, and manufacturing, medical parts to bring new, usable manufacturing technologies to industry. The Medical AMRC will push these technologies to their limits in terms of performance and materials selection, as well as aiding SME's to carry out non-destructive analysis of manufactured component parts in various materials.

For more information, contact:
Craig Roberts,
Head of Design & Prototyping Group
c.roberts@amrc.co.uk www.medicalamrc.com

Resources

The following pages give full details of our equipment, housed in the AMRC Design Prototyping and Testing Centre.

▸ Click page to jump

Trumpf TruLaser 5030 fiber

Laser cutter for thin and thick sheet metal.

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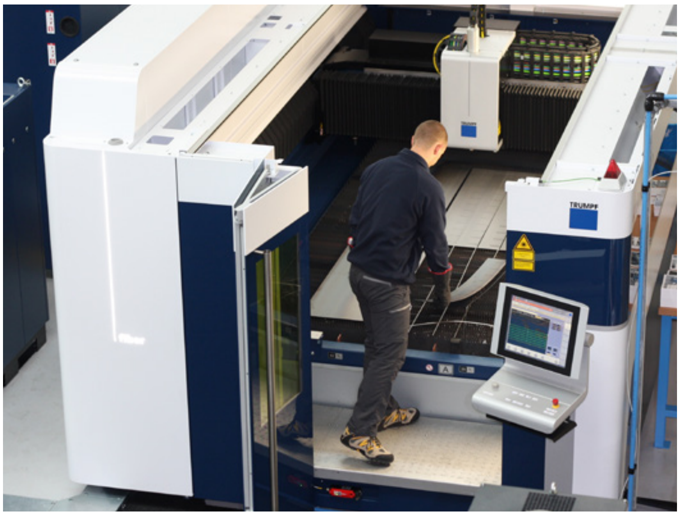
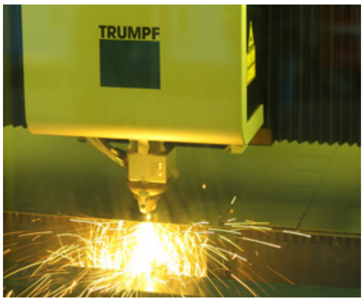
The TruLaser 5030 is a high-performance laser cutting machine capable of high precision on thick metal sheets. The machine features a 3 kW TruDisk 3001 fibre-guided laser with a beam quality of 4 mm mrad.

Type	2-axis fibre laser cutter
X-axis travel	3000 mm
Y-axis travel	1500 mm
Z-axis travel	115 mm
Max material thickness	Mild steel: 20 mm Stainless steel: 15 mm Aluminium: 15 mm Copper: 6 mm Brass: 6 mm
Max axis speed (simultaneous)	265 m/min
Max laser power	3 kW
Laser beam quality	4 mm mrad
Additional functionality	Air and Titanium cutting capability.





DMU 50 Ecoline

Universal milling machining for five-sided machining.

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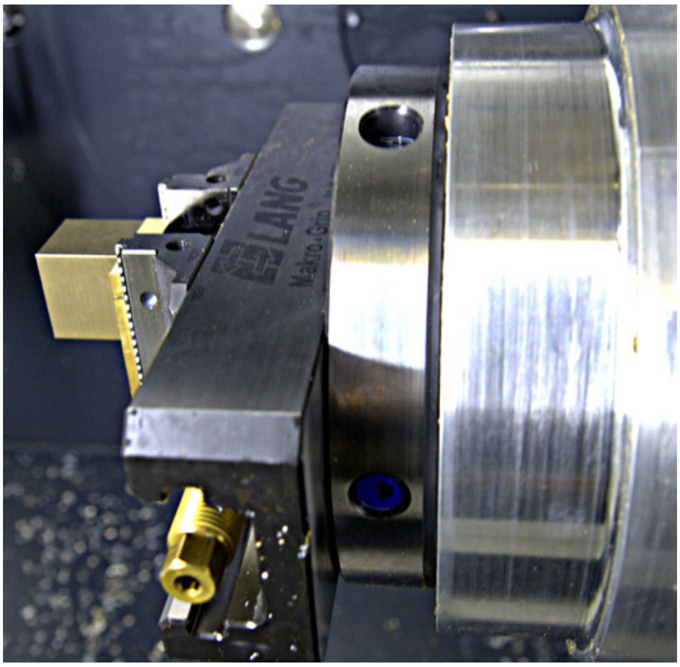
The DMU 50 offers accurate five-sided machining of complex workpieces. The patented NC swivel rotary table enables an accuracy of up to 0.008 mm on the direct measuring system, or 0.02 mm for indirect measuring.

Type	3 + 2 axis milling machine
X-axis travel	500 mm
Y-axis travel	450 mm
Z-axis travel	400 mm
B-axis travel	-5° to +110°
Rapid traverse	2,160°/min
Clamping surface	Ø630 x 500 mm
Load height	790 mm
Max table load	200 kg
Max torque	83 Nm
Max power	13 kW



DMG Sauer Ultrasonic 10

High-precision milling with ultrasonic machining for the most challenging materials.

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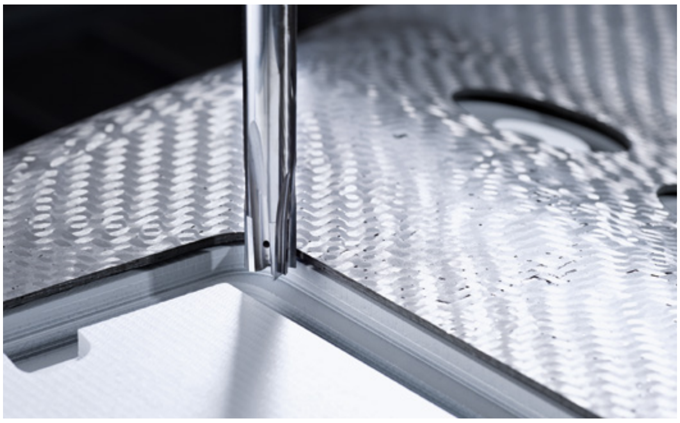
The Sauer Ultrasonic 10 combines high-precision milling capabilities with advanced ultrasonic machining. By oscillating the cutting tool at ultrasonic frequencies, it can precisely drill and grind hard-to-machine materials, including glass, with very low process forces.

The Ultrasonic can produce an extremely high quality surface finish (Ra $< 0.1\mu m$ for some materials) with reduced micro-cracks, and is ideal for thin-walled structures. The centre has been designed for medical and dental, tool and mould-making, watches, aerospace, pumps and valves, and optics applications.

Type	5-axis simultaneous, ultrasonically assisted milling machine
X-axis travel	120 mm
Y-axis travel	120 mm
Z-axis travel	200 mm
A-axis travel	-10° to +120°
C-axis travel	360°
Max spindle speed	40,000 rpm
Max torque	1.6 Nm
Max power	6 kW



Blohm Jung Profimat MC607

Flexible grinding centre.

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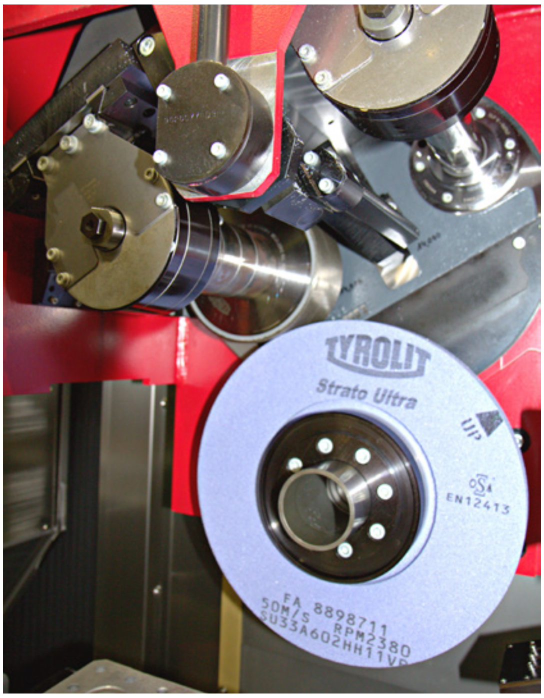
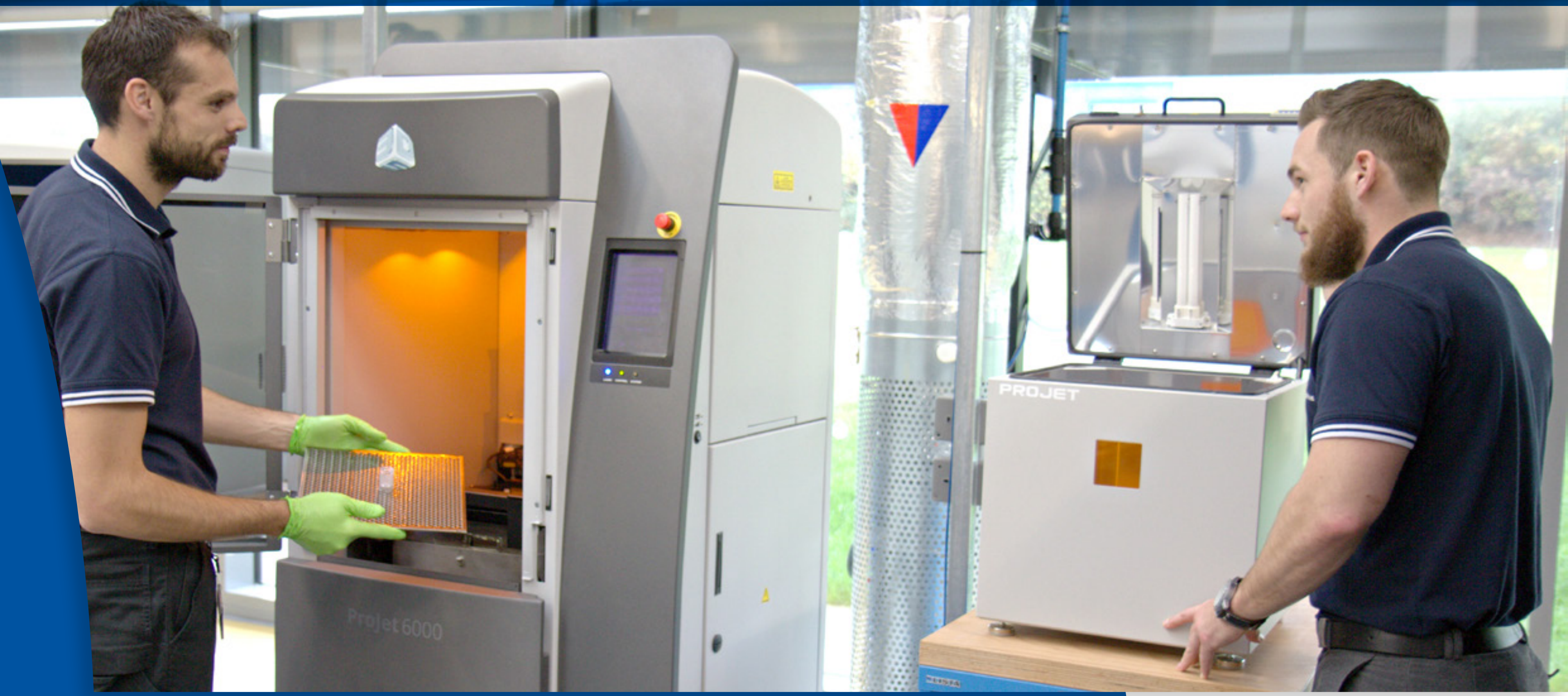
The Profimat MC607 is a compact but flexible grinding centre, capable of precision, profile, internal or external cylindrical grinding.

Type	5-axis simultaneous continuous dress grinding machine
X-axis travel	700 mm
Y-axis travel	650 mm
Z-axis travel	520 mm
Max spindle speed	8,000 rpm
Power	52 kW





3D Systems ProJet 6000SD

Professional stereolithography for the toughest applications.

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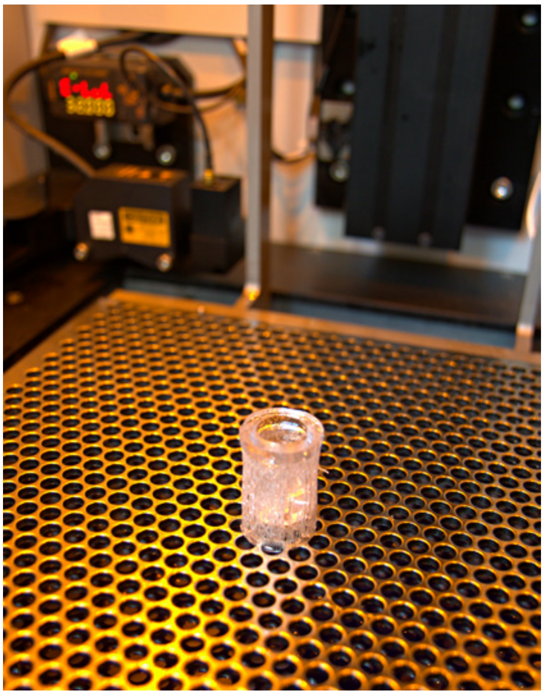
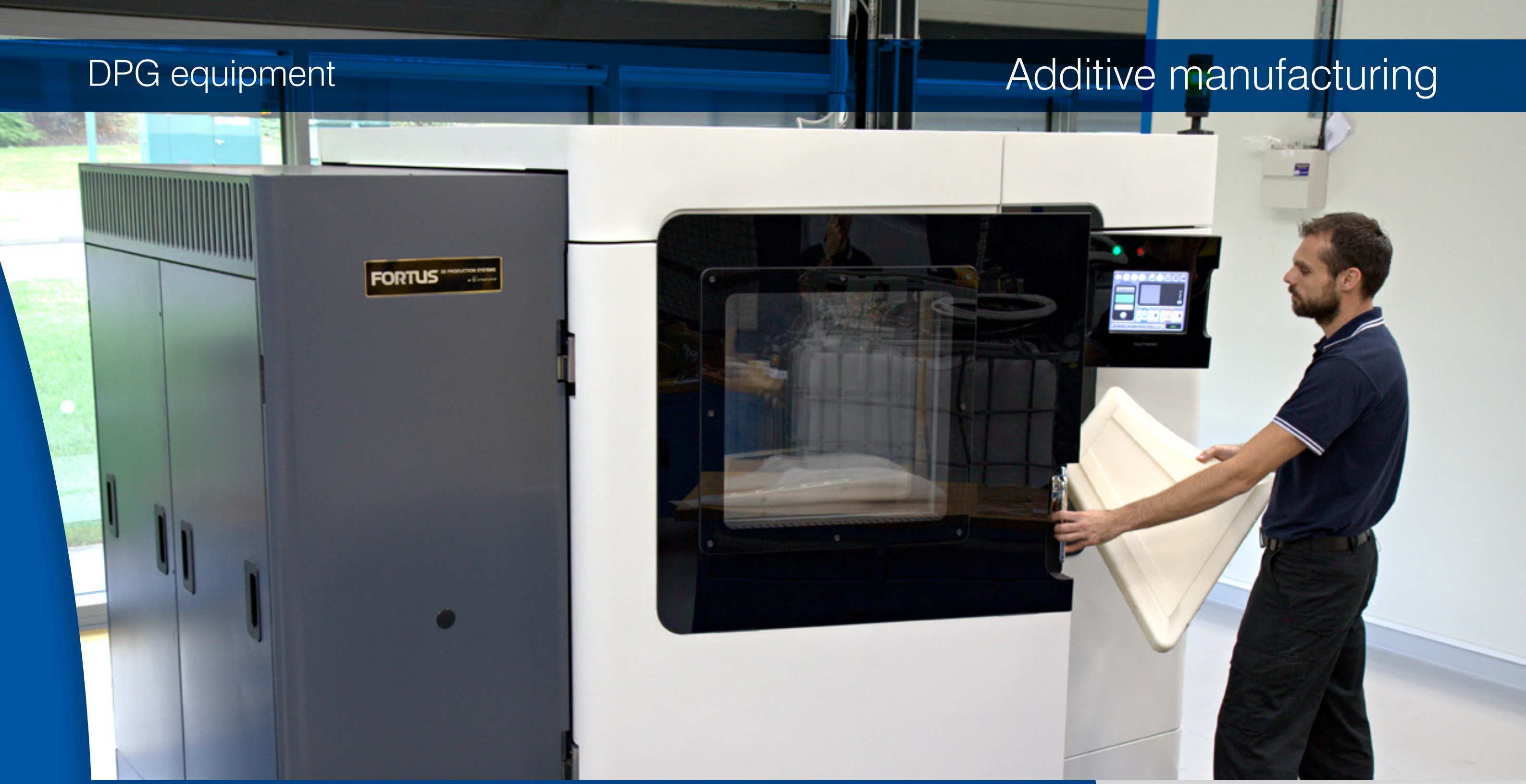
The ProJet uses the well-established resin stereolithography technique to produce high-precision prototypes and short-run parts in up to five VisiJet SL materials.

Type	Resin stereolithography additive manufacturing machine
X-axis travel	250 mm
Y-axis travel	250 mm
Z-axis travel	250 mm
Layer resolution	0.125 mm
Model materials	VisiJet SL HiTemp VisiJet SL Black VisiJet SL Clear VisiJet SL Flex VisiJet SL Impact VisiJet SL Jewel VisiJet SL Tough





Stratasys Fortus 900mc

Large, flexible 3D-printing centre for high-performance plastics.

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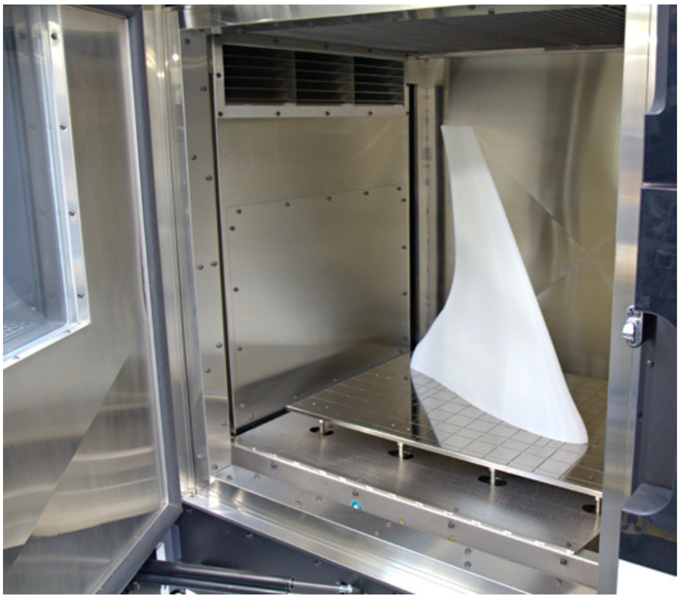
The Fortus 900mc builds large, accurate and repeatable parts from high-performance thermoplastics. In addition to demanding 3D-prototyping applications, the Fortus is suitable for creating fixtures, tooling and end-use parts. It offers a choice of three layer thicknesses and nine material options.



Type	Fused deposition modelling (FDM) machine
X-axis travel	914 mm
Y-axis travel	610 mm
Z-axis travel	914 mm
Layer resolution	0.330 mm / 0.254 mm / 0.178 mm
Accuracy	±0.09 mm absolute accuracy, or ±0.0015 mm per mm build (whichever is greater)
Model materials	ABS-ESD7 ABSi ABS-M30 ABS-M30i PC PC-ABS PC-IS PPSF ULTEM 9085

Stratasys uPrint SE Plus

Flexible 3D-printing for rapid prototyping and modelling.

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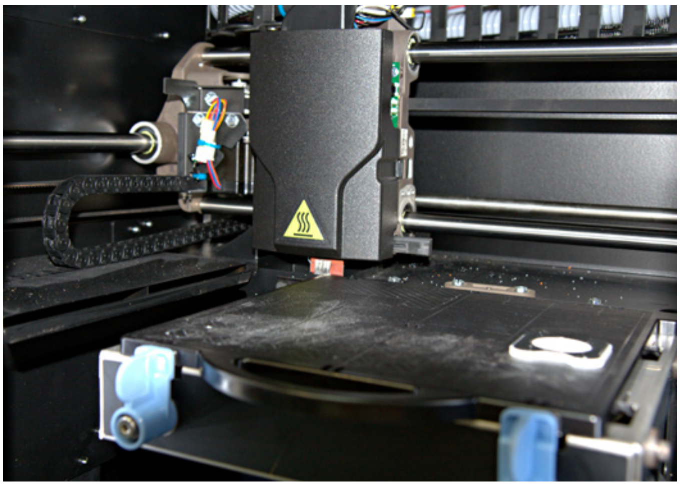
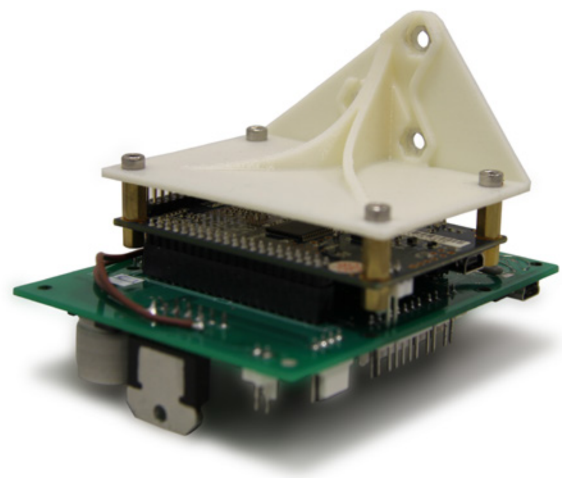
The uPrint SE Plus is a flexible FDM machine capable of creating durable, stable and accurate models and functional prototypes. It offers two layer thicknesses and uses ABSplus thermoplastic in a choice of colours.

The CatalystEX software converts standard CAD files into 3D modelling print paths, including any necessary support structures.

Type	Fused deposition modelling (FDM) machine
X-axis travel	203 mm
Y-axis travel	203 mm
Z-axis travel	152 mm
Layer resolution	0.254 mm / 0.330 mm
Model materials	ABSplus in nine colours





Stratsys Mojo

Desktop 3D-printing of professional-quality models.

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The Mojo is a professional-quality desktop 3D printer, capable of creating small concept models and rapid prototypes in ABSplus thermoplastic.

Type	Fused deposition modelling (FDM) machine
X-axis travel	127 mm
Y-axis travel	127 mm
Z-axis travel	127 mm
Layer resolution	0.178 mm
Model materials	ABSplus in nine colours

Renishaw AM250 - Direct Metal Laser Sintering

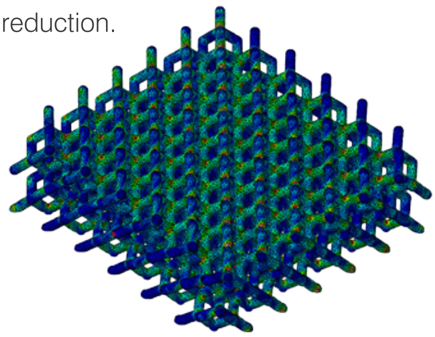
Forms the most challenging of geometries, impossible through conventional processes.

MEDICAL AMRC

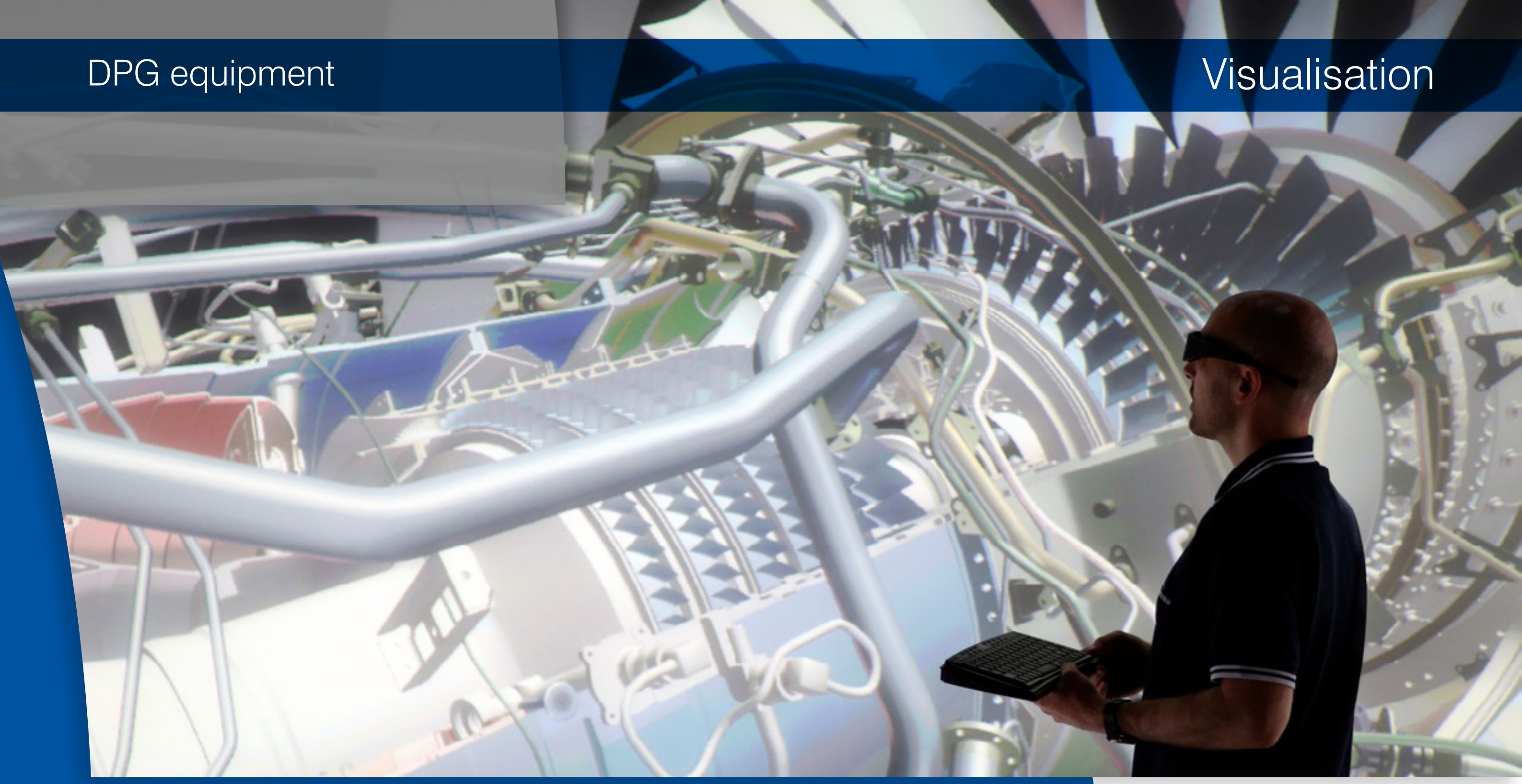
The Renishaw AM250 is capable of CAD driven direct additive manufacturing in a range of medical grade metals. The technology is driven through a high powered 200 W ytterbium fibre laser which allows for fine metallic powders to be fused, to form the most challenging of geometries, impossible through conventional processes.

Typical Medical Applications:

- Surgical instrument kit manufacture.
- Patient specific orthopaedic implant design and development.
- Reconstructive surgical aids for maxillofacial or cranial application.
- Cadaver training guides and test product.
- Reverse engineering applications.
- Component weight reduction.



Type	200 W Direct Metal Laser Sintering manufacturing machine
Build envelope	245 x 245 x 360 mm (X, Y, Z)
Layer resolution	Layer thicknesses available in 30, 50 or 60 micron
Accuracy	Dimensional accuracy geometry dependant. Customisable laser process themes to achieve specific surface finishes 5 to 30 Ra and thin walls < 0.3 mm
Material	Ti6AL4V powder grade 23
Additional materials	Inconel 718, Stainless Steel 316L, Cobalt Chrome and Aluminium AlSi10 Mg
Build rates	up to 20 cm³ p/hr
Fully dense components to near net shape manufacture	
Processing of components within a high purity Argon atmosphere at less than 100 parts per million oxygen levels Minimal material waste as over 98% of powder is re-usable post processing	



Virtalis ActiveWall

Immersive, interactive virtual reality environment.

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The ActiveWall is a large screen wall with 3D back projection for presenting virtual environments to small groups. Its operating system is compatible with a wide range of datasets, and the ActiveWall be used for design reviews, virtual assembly, training, factory layout, simulation, and many other tasks.

Virtual Reality (VR) takes the risk out of change.

VR allows experimentation in a safe environment, independent of scale, giving the user greater flexibility and reducing the cost of change.

The AMRC has five virtual reality facilities across its site, which can be linked together to create a single environment experience. The Design & Prototyping Group's system is also part of a cross-centre High Value Manufacturing Catapult project to allow Visualisation and Virtual Reality (V/VR) facilities at the seven Catapult centres of excellence to be networked.

The Government-backed Catapult helps companies of all sizes to develop new technologies so that they become commercial realities.

Its integrated, networked approach to V/VR will allow partner companies, local SMEs internal Catapult projects and other Catapult centres to use the facilities as 'local' delivery nodes, reducing the cost, time and environmental impact of collaborative projects.

Type	Immersive 3D interactive environment
Screen size	4 m x 3 m
Projection	Christi Mirage S + 6k
Tracking	Intersense IS-900

Nikon Metrology XTH 225 / 320 LC

CT scanning provides vital non-destructive information to aid design optimisation.

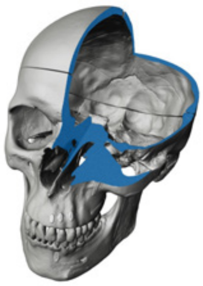
MEDICAL AMRC

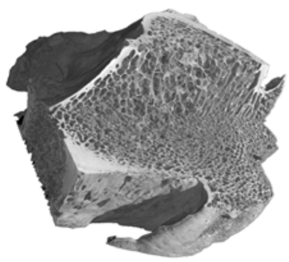
X-ray computational tomography is an essential capability for developing design and manufacturing processes for new technologies.

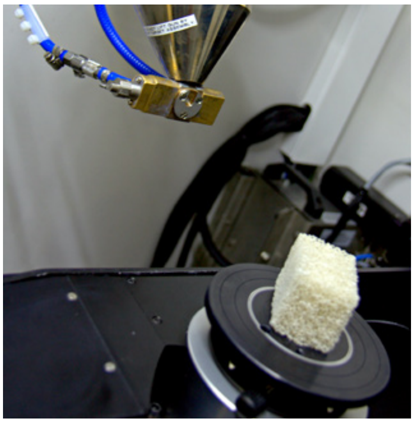
Insight into organic and inorganic structures provides critical information which feeds back into design optimisation.

- Non-destructive inspection of complex internal structures.
- Measure internal dimensions with high accuracy without sectioning part.
- Inspect porosity and defects for developing new design processes for additive layer technologies.
- Inspect internal structures of a wide range of materials – composites, metals, polymers, ceramics, bone, foams.
- Compare scanned geometry to original CAD files to analyse variance and optimise design and manufacture.
- Fibre analysis to calculate fibre orientation and concentration, as well as deviation from predefined orientations.

Type	225 kV / 225 W and 320kV / 320 W micro focus X-Ray sources (Multi-metal target)
Resolution	3 - 200 micron and 30 - 300 micron
Detector	Perkin Elmer 1620 flat panel 16-bit detector (2000 x 2000 pixels)
Geometric magnification	up to x150
Sample weight	up to 100kg
Scanned artefact dimensions	Up to 600 mm (height) x 600 mm (diameter) 200 mm x 200 mm maximum scan envelope
Image processing and reconstruction	VGStudio MAX 2.2







AMRC with Boeing
Advanced Manufacturing Park
Wallis Way
Catcliffe
Rotherham
S60 5TZ

e: enquiries@amrc.co.uk
t: +44 (0)114 222 1747
w: amrc.co.uk

CATAPULT High Value Manufacturing

European Union
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