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Our mission is to revolutionize robotic finishing of near-netshape parts and strengthen the UK's position in advanced manufacturing. Innovate UK's support has been crucial in accelerating our development.

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# **Robotics expert demonstrates faster**, cheaper and safer method for finished **3D-printed components**

A robotics specialist has demonstrated a faster, cheaper, and safer approach to finishing 3D-printed components that could transform tightly regulated industries.

Rivelin Robotics, based in Sheffield, has collaborated with aerospace manufacturer GKN Aerospace, orthopaedic and dental implant manufacturer Attenborough Dental Laboratories and turbomachinery manufacturer Material Solutions on a collaborative R&D project backed by Made Smarter Innovation.

INNOVATION **NETWORK** 

The project, CAMPFIRE (Certified Additive Manufactured Parts Finished with Intelligent Robotics Engine), developed two robotic demonstrator micro-factories to automate finishing for parts and components. Powered by Rivelin's NetShape 2.0 software platform, these micro-factories enable the planning, simulation, and execution of robotic machining operations, inspections, and measurements without requiring CAM, CNC, robotics, or computer programming expertise.

Chris Needham, Innovation Lead for Innovate UK, commented: "This is a fantastic example of how late-stage robotics innovation can accelerate productivity, sustainability, and resilience further developing the capability for in factory production areas.

"This project has the potential to enhance process automation and efficiency in sectors where such improvements are difficult to achieve. The significance of these innovations for the UK economy cannot be overstated,

and our funding supports them as they pave the way for a smarter, more resilient manufacturing landscape."

#### THE INSPIRATION

Post-processing metal AM (Additive Manufacturing) parts is a well-known bottleneck, particularly at scale. Traditional methods are labourintensive, time-consuming, costly, and pose safety risks.

Rivelin has developed a robotics solution: an enclosed microfactory that integrates an industrial robot with a variety of tools, cutting-edge sensors, and their teaching, simulation and control software NetShape. Using both machine learning and traditional control theory, this solution optimizes the quality and repeatability of tasks such as support removal and surface finishing.

Since launching in 2022, the technology has already demonstrated its ability to automate post-processing in industrial settings. Now, Rivelin is focused on tightly regulated industries, including aerospace, defence, medical, energy, and automotive. The goal is to unlock growth and investments in automation and AM, ultimately boosting productivity, sustainability, and resilience in UK manufacturing.



For GKN Aerospace, manual support removal from complex aerospace components has been a major bottleneck in scaling AM for improved productivity, sustainability, and performance.

 At Material Solutions, a Siemens Energy business, the use of metal AM to manufacture highly complex gas turbine components is growing rapidly. However, the current support removal process - which involves multiple machining steps, tools, and manual surface finishing - remains timeconsuming and inefficient.

Attenborough Medical, which uses also explored how the proposed AM to meet the growing demand for personalized and custom implants, also faces challenges with manual post-processing, especially for small, fragile components.

### THE INNOVATION

The R&D process included four key phases: scoping the challenges, designing technology demonstrators, testing the solution on real components, and trialling and analysing the results compared to existing processes.

Phase 1: A deep dive into each use Rivelin choose the optimal case helped identify challenges, manufacturer requirements, and task complexities. The team



solution could be integrated into existing factory settings.

Phase 2: Rivelin focused on developing cyber-secure deployment infrastructure, enhancing machining accuracy, automating calibration routines and integrating force control and optical machine vision into the use cases, allowing the robot to "touch" and "see" during processes such as polishing and milling.

Saint Gobain Abrasives, a leader in grinding technology, helped abrasives, burrs, and bits for finishing tasks.





#### INNOVATION **NETWORK**

With integrated sensors and visual scanning, the robot can now measure the part, detect features, verify outcomes, and introduce rework stepsadjusting the execution flow based on feedback.

The project also improved its core sensing strategy, allowing robots to handle heavier components—up to 450kg, up from the original 60kg limit. The team also redesigned the robotic wrist for faster and more agile tool changes, incorporating electrical, pneumatic, and coolant connections for greater flexibility.

The result was the development of two robotic microfactories. One is capable of handling components up to 700x700x700 mm and 450 kg, designed for large components



such as rotors and turbine vanes. Phase 4: Validation and quality The other is designed for smaller assurance tests compared components, up to 250x250x250 mm and 60 kg, such as medical implants and partial dentures.

Both micro-factories are controlled by Rivelin's NetShape requirements. 2.0 software, enabling users to plan, simulate, and execute robotic machining operations without specialized knowledge in CAM, CNC, or robotics. Key features of the software include closed-loop inspection, rework capabilities, advanced tool path planning, and automatic calibration.

Phase 3: GKN, Material Solutions, part (from 2.1 hours to 1.5 hours). and Attenborough Medical sent parts to Rivelin for postprocessing using the new robotic 24/7. The cost per part also solution.

GKN Aerospace sent an Inconel turbine rotor from a rocket engine turbo-pump for support removal and surface smoothing.

Attenborough Medical sent a Cobalt-Chrome partial denture for support removal and surface polishing.

Material Solutions provided an Inconel nozzle guide vane for gas turbines, to have its leading edge supports removed and aerofoil surface cleaned and blended.

the results of robotic finishing to manual methods. The participating manufacturers confirmed that the robotic solution met or exceeded their

#### THE IMPACT

The outcomes varied across the three use cases, but the consensus was that the hardware and software are viable for production lines.

For Material Solutions, robotic finishing significantly reduced processing time by 28% per This equates to a 50% increase in throughput when operating decreased by 24% (from £64.65 to £48.87). As a result, Material Solutions identified several components that would benefit from automated finishing and plans to deploy the technology in the next 12-18 months.

Trevor Illston, Chief Manufacturing Engineer at Material Solutions, said: "The completed vanes show considerable promise for the future."

For Attenborough Medical, the trials demonstrated that the parts met the required geometry and surface finishing standards.

However, the tight margins in the medical and dental markets remain a commercial barrier to broader adoption. Rivelin and Attenborough are jointly developing a servitised business model, where users pay per part or per kilogram.

Ed Attenborough, CEO of Attenborough Medical, added: "Being part of Project CAMPFIRE has been an obvious choice as we pursue a game-changing digital post-processing solution."

Though the aerospace demonstration for GKN was delayed, the trials supported the technology's development, helping Rivelin secure a sale to a leading aerospace corporation.

Brad Hughes, Principal Research Engineer for Additive Manufacturing at GKN Aerospace, said: "This technology offers numerous benefits to aerospace users, including the elimination of human intervention and improved repeatability and productivity. Working with Rivelin has allowed us to assess their system and specify upgrades for future scalable adoption in aerospace."

In addition to the aerospace deal, Rivelin has secured a sale with an automotive manufacturer and is in advanced talks with another aerospace customer.

Rivelin has incorporated partner feedback into the release of

NetShape 2.0, opening new opportunities. The company has also hired four additional engineers to meet the anticipated rise in to support its growth.

Robert Bush, CEO of Rivelin Robotics, stated: "Our mission is to revolutionize robotic finishing of near-net-shape parts and strengthen the UK's position in advanced manufacturing. Innovate UK's support has been crucial in accelerating our development. This project has increased visibility in key markets, leading to new international orders and positioning





*Rivelin for further growth. We're now* preparing to expand our operations demand for robotic solutions."



