

Innovation Matters

Your journey to Industry 4.0 starts with data

Unlock the power of your manufacturing data with Renishaw Central. Our powerful manufacturing connectivity and data platform can help you exploit digital twin and Industry 4.0 technologies today.

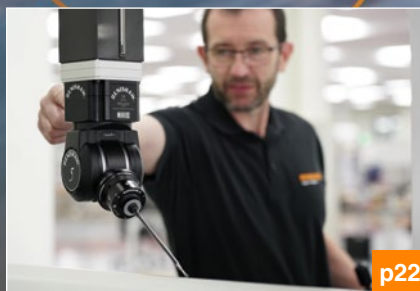
In this issue:



p06

Feature: Why innovation matters

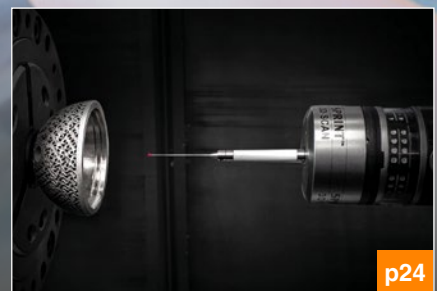
Helping our customers to effectively and competitively deliver products that touch the lives of billions worldwide.



p22

Interview: From our shop floor

Get an exclusive insight into our manufacturing operations, as our UK production teams share their solutions.



p24

Feature: The total AM process chain

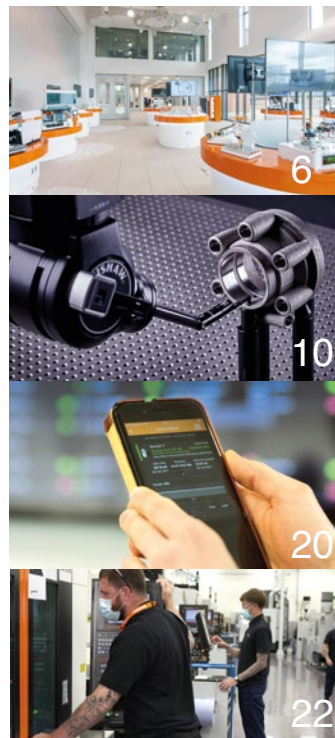
From highly productive metal 3D printing to control of finishing and downstream processes.

Transforming tomorrow, together

We're Renishaw – a leading global engineering and scientific technology group with expertise in high-precision metrology, additive manufacturing and healthcare.

For nearly 50 years, we've been delivering high-quality manufacturing solutions and providing our partners with exceptional global support. Today, we continue to work hard to understand our customers' needs and to provide cost-effective, efficient and easy-to-use solutions. Our long-term approach to research and development and our dedication to innovation also allow us to create original products that, in turn, enable our customers to change the world with theirs.

At the heart of our business, though, are our people, our values and our culture. With this edition of Innovation Matters magazine, we invite you to take a closer look inside our world...



In this issue:

- 03 Manufacturing response to COVID-19: Restart, recover, reimagine
- 06 Why innovation matters
- 08 Automotive engineering: On the road from ICE to EV
- 10 Product showcase: Innovations for part inspection and gauging
- 14 Product showcase: Innovations for machine tool builders
- 17 Product showcase: Innovative custom solutions
- 18 Product showcase: Innovations for machine tool users
- 20 Product showcase: Software and digital innovations
- 22 Interview: From our shop floor
- 24 The total AM process chain
- 26 Case study: Machine tool probing increases FMS productivity by 60%

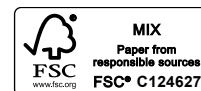
© 2021 Renishaw plc. All rights reserved. Renishaw reserves the right to change specifications without notice. RENISHAW and the probe symbol used in the RENISHAW logo are registered trade marks of Renishaw plc in the United Kingdom and other countries. apply innovation and names and designations of other Renishaw products and technologies are trade marks of Renishaw plc or its subsidiaries. All other brand names and product names used in this document are trade names, trade marks or registered trade marks of their respective owners.

RENISHAW HAS MADE CONSIDERABLE EFFORTS TO ENSURE THE CONTENT OF THIS DOCUMENT IS CORRECT AT THE DATE OF PUBLICATION BUT MAKES NO WARRANTIES OR REPRESENTATIONS REGARDING THE CONTENT. RENISHAW EXCLUDES LIABILITY, HOWSOEVER ARISING, FOR ANY INACCURACIES IN THIS DOCUMENT.

Please note that some imagery in this publication was captured pre-COVID-19.



Once finished with please recycle.



Manufacturing response to COVID-19: Restart, recover, reimagine

As manufacturing industries continue to prioritise safe and responsible working practices, many operations are far from 'business as usual'. Discover how Renishaw is helping its global partners to overcome new challenges created by the COVID-19 pandemic and apply flexible, automated solutions that will support long-term productivity and efficiency gains.

Restart

As well-established manufacturers ourselves, we understand from our own experience that, where social distancing is required within the factory environment, achieving an effective outcome requires the reduction of personnel movement around sites, including the use of restrictive zoning and even altering the layout of the factory floor. The most effective way to achieve this without reducing productivity is to increase automation. For example, adding standard on-machine probing routines to automate traditionally manual activities, such as part set-up and process monitoring, simplifies operations and reduces the manual interventions they require to keep running. Probing is proven to help maximise the efficiency, capability and accuracy of machine tools. It also allows you to accommodate a reduction in allowable staff.



read on...

Manufacturing response to COVID-19: Restart, recover, reimagine

...continued

Adding tool breakage detection allows you to increase unattended production. Use of on-machine sensing equipment will enable operators to multi-task, requiring fewer workers across more machines. Our range of tool setters offers both contact and non-contact tool measurement and broken tool detection during machining.

Local zoning and other restrictions around your factory may limit access to the quality control (QC) room. Decentralising quality functions to individual zones or cells within machining areas raises levels of self-sufficiency within each zone. Our Equator™ gauging system for near-machine process and part validation allows you to carry out simple zone-based quality control procedures with confidence. The Equator gauging system is based on the traditional comparison of production parts to a reference master part. The systems can be used in factories with wide temperature variation – simply re-master and the system is ‘re-zeroed’, ready for repeatable comparison to the master.

Local zoning may also affect the ease of movement between machining areas and tooling areas, and so replacing offline tooling set-ups with on-machine tool-setting systems and using sister tooling can improve up-time and reduce tool room reliance.



Recover

More than ever, manufacturers need the ability to respond to unexpected challenges and adapt processes and equipment accordingly. Factory closures resulting from the pandemic have caused production and measurement backlogs, which create capacity challenges in quality areas. To tackle backlogs and scale up operations with fewer staff, our range of metrology technologies enables faster measurement and fewer devices in quality labs.

As well as automating manual measurements wherever possible, using our REVO® multi-sensor 5-axis measurement system with automation reduces measurement time. The system delivers high-performance scanning, non-contact inspection and surface finish analysis on a single co-ordinate measuring machine (CMM). Reducing the number of inspection devices reduces the number of people required to keep production running.



Our fixturing products also reduce the complexity of CMM set-up. Modular CMM fixtures can improve the throughput, reproducibility and accuracy of your inspection processes by providing quick and repeatable fixturing set-ups for your production components and assemblies.

All Renishaw technologies can be easily integrated to control upstream processes and enable the reprogramming and repurposing of equipment.



There are many reasons why manufacturing staff with valuable skillsets may not be available due to COVID-19. Increased levels of automation for manual operations reduces dependence on skilled engineers who may be unavailable due to machine shop zoning or other restrictions.

Integrating our range of measurement and inspection solutions into your operations can be easy. Introducing on-machine probing, for example, means that you no longer require specialist skills or experience to run every machine tool. The Equator gauging system features push-button operation.

Renishaw software includes easy-to-use real-time process-monitoring apps for use on machine tools and mobile devices. Remote access to all manufacturing and process data and diagnostics allows you to maintain visibility and overall control of the QC function. With more measurement activities taking place on the shop floor, this makes it possible to achieve data-driven manufacturing even with engineers working from home. Customers can also view component measurement data from probing systems on their machine tools, or carry out remote interpretation or analysis by exporting data to other systems.

Our growing software ecosystem makes it easy for your established manufacturing systems to access Renishaw device data and diagnostics remotely. So, even if travel restrictions limit visits by machine tool service staff, you'll have access to up-to-date machine and job information, including metrology, machine status and alert data, in order to carry out machine assessments yourself.

Reimagine

Our unrivalled breadth of metrology technologies can be used throughout the manufacturing process to maximise production output, reduce the time taken to produce and inspect components, and keep machines running reliably.

As manufacturers ourselves, we understand the scale of the challenge that lies ahead for the global manufacturing community. With decades of experience in automated manufacturing and process control, we're perfectly placed to support our new and existing customers as you look to develop your own smarter processes and embrace smart factory automation.

A data-driven approach to process control has perhaps never been more pertinent than it is today, in the wake of COVID-19. The ability to adapt and scale up operations quickly and effectively requires the ability to identify and control sources of process variation before, during and after machining. This unprecedented scenario has afforded the manufacturing sector an opportunity to pause and reimagine how post-COVID-19 factory environments could, and should, operate.

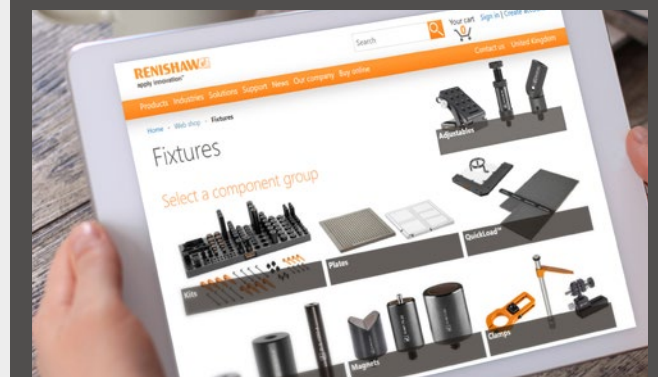
Sharing our support and expertise – online

We're committed to maintaining global supply chains and supporting our customers worldwide. In these unprecedented times for industry, smart manufacturing and automation are now more important than ever. In the past, we have been able to speak to our customers at exhibitions, trade shows and seminars, and visit their factories for consultations and to deliver training.

Now, we are keeping those conversations going with enhanced access to our support and expertise online, including the launch of some exciting new digital initiatives. These include our global webinar programme, hosted by our industry experts, and our Virtual-Expo, where visitors can discover the latest metrology innovations and Industry 4.0 technologies, and see how they are being applied throughout key manufacturing industries.



Additionally, our Web shop has proven to be a convenient and accessible way for our customers to order a wide range of parts and accessories online, further demonstrating our ability to support our global manufacturing customers when they have needed us most.



www.renishaw.com/virtualexpo

www.renishaw.com/webinars

www.renishaw.com/shop

Why innovation matters

Renishaw Innovation Centre, New Mills, UK.

We reveal why applying innovation has been at the heart of Renishaw since we were founded in 1973 – helping us, and our customers and partners, drive forward with real purpose.

A history of innovation

Renishaw was co-founded in 1973 by David McMurtry. Our first product, the touch-trigger probe, was invented by David to solve a specific inspection requirement for the Olympus engines used in Concorde. This innovative product led to a revolution in three-dimensional co-ordinate measurement, enabling the accurate measurement of machined components and finished assemblies.

From this breakthrough moment, through the advent of CNC machining in the late 1970s – a time many believe to be the Third Industrial Revolution – we have continued to develop innovations for machine tool users. Indeed, our sensors for CNC machine tools, which are used for automating machine tool setting operations and in-process part measurement, have greatly improved metal cutting performance to ultimately change manufacturing control, feedback, and confidence during production processes.

Further diversification, aided by our strong focus on research and development (R&D), has led us to develop key innovations such as position encoders for accurate motion control; laser interferometry for machine performance evaluation; Raman spectroscopy instruments for spectral analysis of materials; gauging technologies; metal additive manufacturing (3D printing) systems and software; metrology fixturing systems; styli for probes; and medical devices for neurosurgical applications.

“

We aim to gain a deep understanding of our customers' manufacturing challenges and then produce innovative solutions that answer their real needs.

”

Sir David McMurtry,
co-founder of Renishaw



Focusing on long-term success

To fuel our innovation pipeline, research and development (R&D) has always been at the heart of our business. We typically invest between 13% and 18% of annual revenue in R&D and engineering. This has enabled us to design, develop and deliver solutions that provide unparalleled precision, control and reliability.

Patent and intellectual property generation are core to new product development and our in-house patent attorneys are key members of our development teams. We are prepared to take a long-term view with R&D and continue to develop exciting new patented technology and processes, while also diversifying into new product and market areas. We also work with key universities to supplement our core specialties.

Our strong focus on R&D is underpinned by long-term investments in people, innovation and infrastructure. These nurture a powerful pipeline of measurement technology and manufacturing techniques that advance the development of diverse products and address pressing real-world problems.

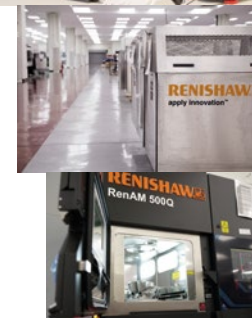
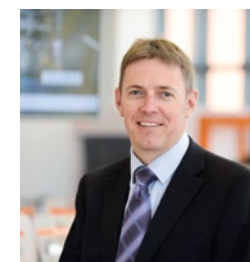
Our people are the vital spark of our innovations. They bring fresh thinking, relentless rigour and a passion for quality to every aspect of their work. Their thirst for innovation and commitment to continuous improvement informs the drive, determination and energy that mean we keep moving forward with purpose, every day.

“

Renishaw grew out of a metrology challenge linked to making supersonic flight a commercial reality. It required innovative problem solving – an approach which still runs deeply through so much of what we do today. Such a focus on innovation is not just centred on the products we create; we also apply innovative thinking to our own or suppliers' manufacturing challenges, and to our operational business processes, to ultimately deliver the products our customers need for their own manufacturing competitiveness. Above all, innovation is such a key part of our DNA – it always has been and it always will be.

”

Dave Wallace,
Director of Group Operations



Transforming tomorrow, together

We work closely with our customers to solve complex challenges and improve products and processes. As a manufacturer ourselves, we can appreciate the problems manufacturers face and use this first-hand experience to shape our product development process to develop innovations that we know our customers truly need.

To discover our latest innovations, go to page 10

Renishaw patents –
continual innovation
in new technologies

1,813



Automotive engineering: On the road from ICE to EV

Automotive R&D is increasingly focused on new propulsion technologies for the next generation of vehicles. The gradual decline in demand for cars powered by internal combustion engines (ICE) will see hybrid solutions emerge to bridge the technological gap between the ICE and the full battery electric vehicle (BEV). And on the road from ICE to EV, there will be a marked increase in the design iterations of hybrid vehicles as technologies are continually refined.

At the heart of EV product development is the pursuit of extended range through motor efficiency and battery effectiveness, both of which rely on highly precise component quality. For example, motors must be increasingly compact and lightweight for higher performance and lower consumption.

With vehicle design evolving at an unprecedented rate, manufacturers must demonstrate innovation and adaptability amid new production challenges. With our range of measurement solutions to support both research and pre-production development, particularly for EVs, we're helping our automotive customers to apply our technology in increasingly innovative ways.

Our automotive partners are keeping pace with advances in vehicle design, using our knowledgeable specialists whose expertise and experience has helped them to pioneer innovative new production processes and competencies.

Take electric motor stators, for example, where the smaller the air gap, the lower the battery power required to drive the vehicle, and therefore the greater the range; just one of the many challenges we're helping our customers to overcome by unlocking the potential of their production equipment and process data.

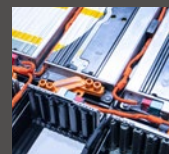
By drawing maximum value from existing technologies and deploying our products in innovative ways, our customers are better equipped to meet their future production needs.

So, how can we help?

Electric vehicles have far simpler mechanics and fewer complex parts than those in ICEs, but EV components often have higher design specifications and require advanced measurement technologies with more process control and capability. Renishaw's in-process measurement solutions provide immediate feedback, which helps ensure your machines are capable of making EV components true to their design specification. It also means you can develop capable manufacturing processes that allow you to control the machining of parts.



www.renishaw.com/automotive



Batteries

Our breadth of scientific and manufacturing technologies has enabled our global automotive customers to progress all stages of battery development.

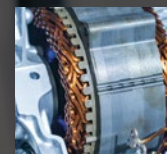
- Raw materials analysis
- Range performance research
- Intelligent machining
- Process control for machining and assembly



Power electronics

Using Raman spectroscopy technologies to understand difficult-to-fabricate semiconductor materials will allow you to develop more powerful electronics.

- Non-destructive semiconductor quality control
- Improved quality and material yield
- Additive manufacturing for developing complex yet lightweight metal parts with greater design freedom



Electric motors

Our range of highly automated inspection technologies support eMotor production, which relies on repeatable processes and in-process checks to deliver accurate components and sub-assemblies.

- High-speed rotor and stator inspection
- 'Go/No-go' checks for hairpin height
- Reduced inspection cycle times



Gearbox noise vibration and harshness reduction

The programmability of our inspection technologies makes them ideal for pre-production. Then, when processes are ready, they can be re-tasked in production.

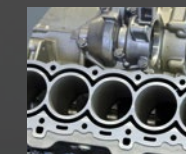
- Equator™ gauging systems for flexible in-line gauging at the point of manufacture
- Closed-loop production process control



Gearbox casings and eMotor housings

Make more measurements with our shopfloor-capable inspection checks using rapid, automated, 5-axis multi-sensor inspection on a single integrated CMM platform.

- 5-axis inspection technologies for reduced cycle times
- Automated surface finish inspection



Combustion engines

Achieve higher engine efficiency and performance with more capable manufacturing, by capturing form data using tactile scanning.

In-process control with on-machine scanning

- Measure parts at high speed
 - Detect problems with feature form
- Component inspection on CMMs
- Surface finish probing
 - 3D data capture of cylinder head combustion chambers

Innovations for part inspection and gauging

REVO® 5-axis measurement system

Accuracy at ultra-high speed

Based on advanced head, sensor and control technology, Renishaw's 5-axis measurement solution delivers unprecedented measuring speed and flexibility, with no compromise in accuracy.

Unlike measurement on conventional 3-axis CMMs, the REVO system uses synchronised motion and 5-axis measurement technology to minimise the dynamic effects of CMM motion at ultra-high measurement speeds.

The probe system offers multiple specialised sensor types, which can be changed automatically. These include tactile scanning, surface finish and structured light measurement, which provide added flexibility and reduce total capital expenditure by minimising the number of inspection devices required.

- The REVO system reduces cycle times and provides actionable data faster.
- Flexible feature access with fewer styli required.
- Additional sensors can be used on the same 5-axis head for multi-functional capability on a single CMM.



www.renishaw.com/revo

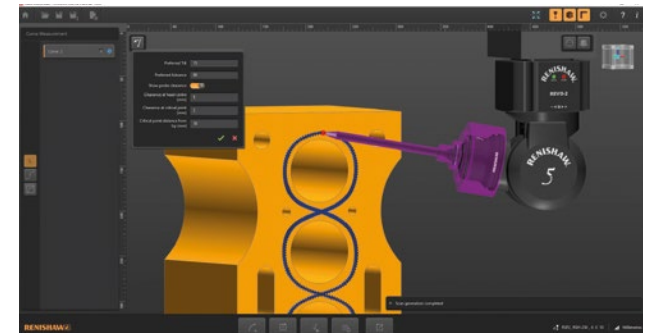


MODUS™ Planning Suite

Automated shortcuts for part programming

The MODUS Planning Suite software is designed to provide CMM users with a set of automated shortcuts to frequent challenges in part programming, maximising the efficiency of their REVO® CMM system with a set of easy-to-use specialised software applications. MODUS Planning Suite allows users to plan complex geometry programs with minimal effort and improved efficiency using three new software tools: MODUS Patch planner, MODUS Curve planner and MODUS Blade planner.

- MODUS Patch planner delivers the most efficient measurement path, quickly and easily, with automatic on-surface path planning.
- MODUS Curve planner incorporates constrained CMM motion, which reduces CMM axis motion when measuring curves on a plane and therefore improves accuracy and repeatability.
- MODUS Blade planner includes Adaptive Edge Scan (AES), a measurement operation used to adapt the position and probe orientations of the edge sweep so that the sweep scan runs smoothly.



www.renishaw.com/modusplanningsuite

OPTiMUM™ diamond styli

High-performance scanning for the toughest environments

Renishaw's new OPTiMUM™ diamond styli range has been developed for use within metrology applications that require a hard-wearing stylus.

The main advantage of its diamond-coated spheres is that they maintain their roundness and do not suffer material 'pick up' or premature wear when scanning abrasive materials or soft alloys. This provides multiple benefits, including an increased working life and reduction in recalibration and inspection downtime.

- OPTiMUM diamond styli balls are extremely wear resistant and retain their form after scanning on abrasive surfaces.
- Material build-up does not adhere to the ball, and any small deposits can be simply wiped away.
- Designed to order, your diamond-coated styli can be made in a variety of thread sizes and stem materials.



www.renishaw.com/styli

Innovations for part inspection and gauging

Equator™ gauging system with automated feedback to CNC controller systems

Controlling manufacturing processes on the shop floor

Renishaw's flexible Equator gauging system is a high-speed comparative gauge for medium- to high-volume manufactured parts. When manually loaded or used in automated cells, the Equator gauge can switch between parts and programs in seconds, validating each production part against a master reference part. Equator systems have improved the yield and increased the process capabilities of thousands of production lines worldwide, offering high-accuracy dimensional data at the point of manufacture.

- Accurate between 5 °C and 50 °C; capable of scanning speeds beyond 200 mm/s.
- Intelligent process control software for updating tool offsets on CNC machines automatically.
- Equator systems can be fully integrated into automated production lines in smart factories.



www.renishaw.com/equator

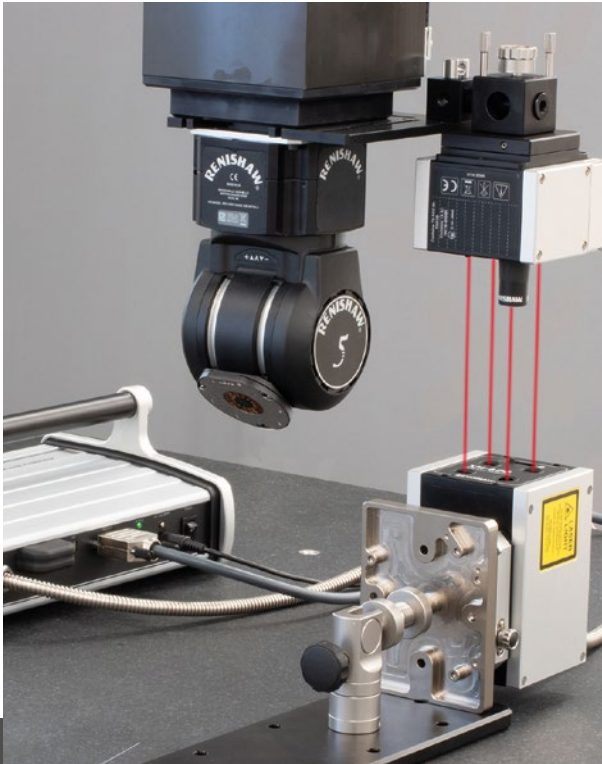
XM-600 multi-axis calibrator

Faster and easier CMM error mapping

Renishaw's XM-600 multi-axis calibrator offers enhanced capability for error mapping with universal CMM controllers (UCCs). It simultaneously measures all six degrees of freedom within a single measurement. This allows accurate error maps for each linear axis of a CMM to be created easily.

The XM-600 communicates with UCC software during the calibration routine to quickly build a complete error map of a CMM within half a day.

- Easy and efficient integration with UCCs.
- Significantly reduce the time to complete an error map of a CMM.
- Provides live graphical display of all six error values.



www.renishaw.com/xm600

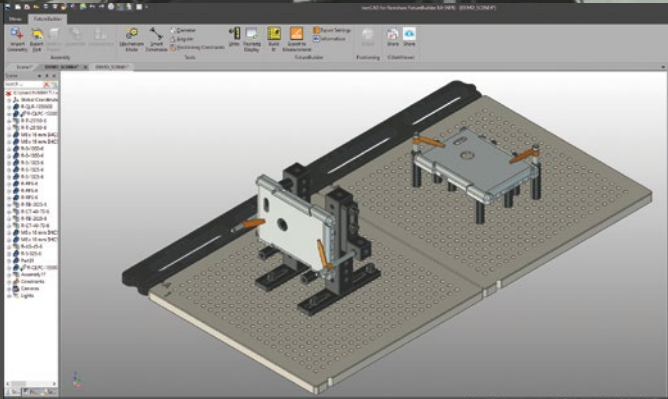
FixtureBuilder 8.0

Flexible 3D modular fixturing software

FixtureBuilder 8.0 is a 3D-modelling software package that is designed to allow the creation and documentation of metrology fixturing set-ups.

The software can be used with a CAD model of the inspected part, which is imported into FixtureBuilder, so that the fixture can be built around it. The entire set-up, along with the inspected part, can then be exported into inspection programming software.

- Import and export most common 3D CAD files, including Parasolid™, Step, ACIS, STL and IGES.
- Create fixturing set-ups and custom plates and store them in user-defined libraries.
- Try our free 30-day trial of the full FixtureBuilder software.



www.renishaw.com/fixturebuilder

INNOVATIONS FOR MACHINE TOOL BUILDERS

FORTiS™ encoder series

Next-generation enclosed linear absolute encoders for use in harsh environments

Our FORTiS encoder series represents the next generation of optical encoders for use in the harshest environments, delivering high-performance position feedback, motion control, metrology and contamination resistance.

The FORTiS encoder features a miniature ultra-high speed digital camera, housed in a sealed readhead, that reads a single track, fine pitched optical steel scale. Robust, reliable, high-performance position measurement over the encoder's long life is ensured by a range of innovative design features.

Machine builders can benefit from significant technical and commercial advantages over conventional designs, such as easy integration, high reliability and enhanced performance for the end user.

The FORTiS encoder offers dramatically reduced air consumption thanks to its advanced sealing system. A reduction of up to 70% in air purge requirements compared to other optical enclosed encoders can drastically cut the cost of operation while also reducing a machine's carbon footprint.

Our new enclosed encoder adds to Renishaw's proven encoder technology portfolio, reinforcing the wider support that our trusted industry expertise can offer machine builders.

- **Increase system performance and longevity with ground-breaking non-contact design for dramatically improved metrology, feedback and vibration resistance.**
- **Improve uptime with the help of DuraSeal™ lip seals, which provide protection against liquid and swarf ingress, including sealing performance up to IP64 with air purge.**
- **Save time and reduce costs with a unique set-up procedure, aided by Renishaw's patented set-up LED, which makes installation quick, simple and intuitive.**



www.renishaw.com/fortis

XK10 alignment laser system

Measure geometric and rotational errors during machine build, maintenance and service

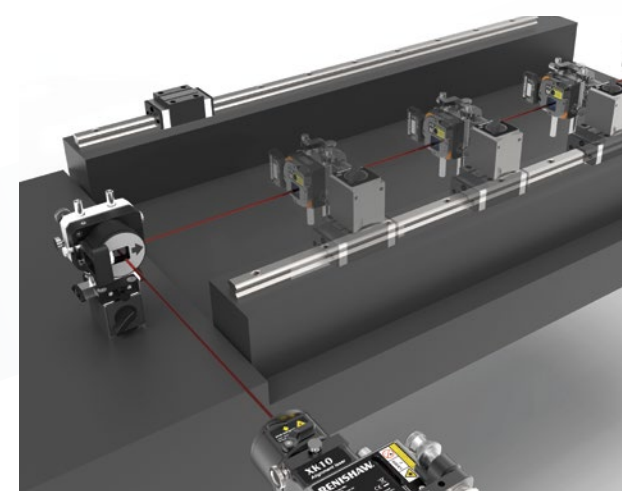
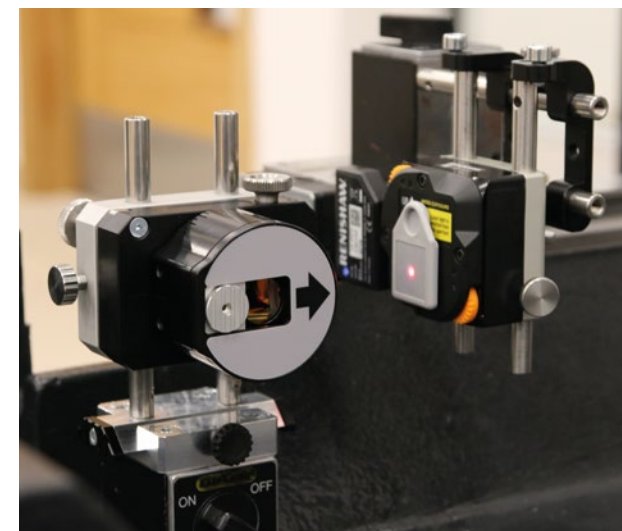
Our XK10 alignment laser system measures geometric and rotational errors during machine build, maintenance and service, for accurate alignment and adjustment of machine axes to achieve optimum performance.

Updated software for the XK10 allows point-to-point parallelism measurements to be performed. This means that you can make adjustments to machine parallelism with a precision that would not be possible using traditional measurement techniques.

- **Diagnose the source of errors following a rebuild or as part of regular maintenance.**
- **Achieve visibility of the mechanical alignment of a machine's structure during assembly.**
- **Perform adjustments during build with the help of digitally displayed measurements.**



www.renishaw.com/xk10

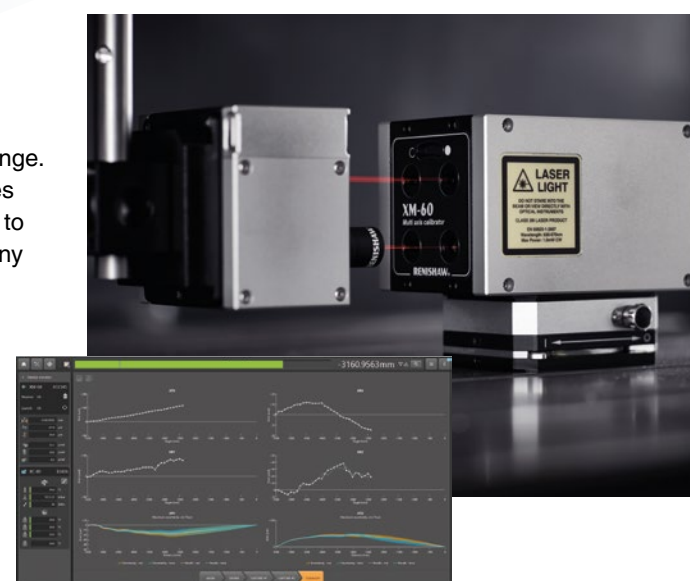


XM-60 multi-axis calibrator

New software mode enables long-range measurement

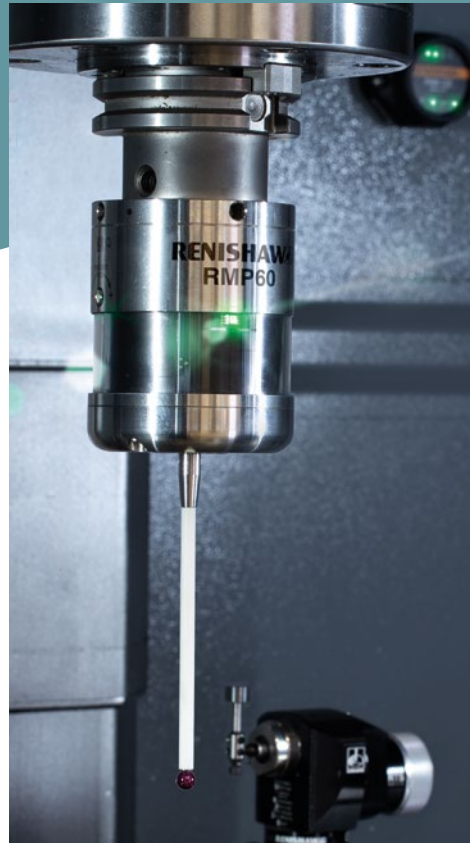
For the first time, it is now possible to use the XM-60 multi-axis calibrator with an unlimited measurement range. The latest release of Renishaw's CARTO software uses the dynamic data fit functionality to allow XM-60 users to quickly capture and analyse data from linear axes of any length. Dynamic data fit mode offers greater resilience in noisy environments and a better representation of straightness errors for longer axes.

- **Measure all six degrees of freedom in any orientation, from a single set-up.**
- **View results while the test is in progress for added reassurance.**
- **Minimise human error with automatic sign detection and graphical alignment.**



www.renishaw.com/xm60

INNOVATIONS FOR MACHINE TOOL BUILDERS



RMI-QE series

Delivering a data-rich future and an increase in battery life of up to 400%

Our next-generation radio transmission probing system consists of an ultra-compact RMI-QE radio interface with an updated communication protocol, as well as major updates to our complete range of market-leading radio transmission probes. This technology enables reliable, automated on-machine tool setting, tool breakage detection, part set-up and part verification capability.

Future-proof – the RMI-QE interface features an updated communication protocol to support a new generation of Renishaw sensors and smart devices.

Environmentally friendly – the probes now offer an industry-leading battery life of up to five years based on typical usage.

User friendly – probe settings can now be configured via the new Probe Set-up smartphone app, as well as remote diagnostics via applications such as iMessage®, WhatsApp, LINE and WeChat.



www.renishaw.com/qeseries

ADTa-100 Advanced Diagnostic Tool for absolute encoders

Your toolkit for enhanced encoder set-up

Our range of Advanced Diagnostic Tools is designed to aid set-up and diagnostics for Renishaw position encoders. These tools acquire detailed real-time data from the readhead to allow easy set-up optimisation and in-field fault-finding. The newly introduced ADTa-100 now offers these benefits for the RESOLUTE™ and EVOLUTE™ absolute encoder series.

- ADTa-100 acquires comprehensive real-time data from the readhead which assists with straightforward and quick encoder installation.
- Operates either in standalone mode, displaying signal size and encoder status through its built-in 7 LED array, or with the ADT View software interface.
- Compact form factor allows easy storage, transport and use.

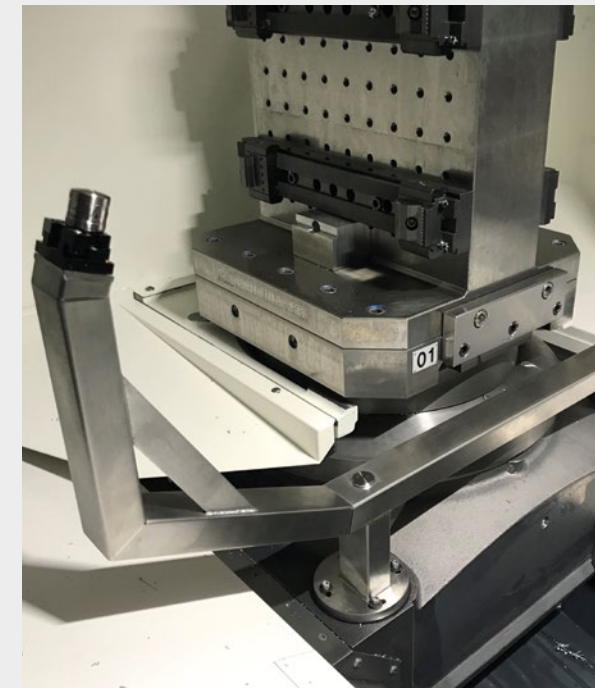


www.renishaw.com/adt

INNOVATIVE CUSTOM SOLUTIONS



Custom solutions for machine tools



Over 30 years of bespoke designs

Our custom products team has been established for over 30 years. We have unparalleled experience and expertise in providing custom-designed products and accessories that meet with machine builders' exacting requirements.

Ranging from specialist styli to full probing systems, we offer engineering and applications advice and a design service backed by our unrivalled global service and support network.

- Every custom product is built to the same high levels of quality as our standard product range.
- Design and manufacturing solutions based on Renishaw's knowledge and experience in product applications worldwide.
- Over 4,000 special styli, 500 bespoke tool-setting arms and 200 machine-specific retrofit kits have been designed and produced in the last five years.

Custom solutions for styli and fixturing

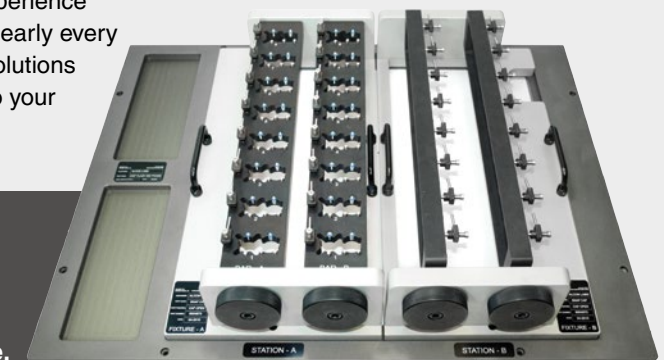
If a standard product can't do the job, allow our in-house teams to design a solution

We can provide a total custom solution for your styli or metrology fixturing needs, where a standard solution may not be suitable.

We use our own extensive experience as a manufacturer to develop solutions that address the needs of our global customers. We understand the many and wide-ranging inspection challenges that you face. As your partner for innovative manufacturing, our in-house design teams share their wealth of experience and expertise to design and manufacture custom products to suit nearly every requirement. In fact, with over 15,000 different Renishaw custom solutions already supplied into probing applications worldwide, the answer to your custom stylus requirements may already exist.



- Renishaw has supplied over 15,000 different custom solutions into probing applications worldwide.
- Through our extensive and experienced applications network, we can provide full technical support and guidance.
- We have extensive performance and quality testing capabilities.



www.renishaw.com/customsolutions

Innovations for machine tool users

NC4+ Blue non-contact tool setter

A step-change in tool measurement accuracy

Our latest evolution of non-contact tool setters features an ultra-compact design and is now available in four sizes, with operating gaps ranging from 55 mm to 240 mm. Measurement repeatability has also been improved across the range, now down to $\pm 0.5 \mu\text{m}$ on smaller separations.

- Measure very small tools while minimising tool-to-tool measurement errors – a critical consideration when machining with a wide range of cutting tools.
- Ensure fast and reliable tool measurement, even in wet conditions, with the help of dual measurement mode and auto optimisation technology.
- MicroHole™ and PassiveSeal™ optical protection technologies ensure the system is always fully protected, even during measurement.
- User-friendly programming, reporting and data streaming using our range of on-machine and smartphone apps.



www.renishaw.com/nc4blue

On-machine scanning probe with SPRINT™ technology

Fast and accurate machine tool probe providing touch-trigger and on-machine scanning capability

Minimise cycle time and maximise productivity with Renishaw's OSP60 probe with SPRINT™ technology. Featuring a unique 3D sensor, this exceptional machine tool probe provides high-speed, high-accuracy scanning for rapid on-machine part set-up, in-process control and machine health check applications.

Highly responsive to surface variation and capable of detecting sub-micron movement at the probe stylus tip, the OSP60 captures 1,000 true 3D data points every second. The OSP60 is ideal for a diverse range of on-machine applications.

- Measure complex 3D surfaces at high speed and analyse data in real time for automated in-process control and verification of machine capability.
- Capture absolute XYZ surface data with 1,000 points per second.
- Use analysis tools optimised for industrial applications, including machine health check, high-speed part set-up, surface condition monitoring and adaptive machining.



www.renishaw.com/sprint

AxiSet™ Check-Up

Fast health checks for multi-axis machine tools

AxiSet™ Check-Up offers an easy and reliable process for analysing the performance of rotary axes and for identifying problems caused by incorrect machine set-up, collisions or wear. Users of multi-axis machining centres and multi-tasking (mill-turn) machines can quickly identify poor machine alignment, geometry and pivot point errors that can cause extended process setting times and non-conforming parts. Where possible, AxiSet Check-Up automatically corrects on-machine pivot point parameters.

- Measure and report on machine performance in a matter of minutes.
- Achieve accurate and consistent results using fully automated probing tests.
- Track machine performance over time using the AxiSet Check-Up app, which displays measurement data graphically.



www.renishaw.com/axiset

Software and
digital innovations

Renishaw Central

Unlock the power of your manufacturing data with Renishaw Central

Renishaw Central is the powerful manufacturing connectivity and data platform born out of our need to digitalise end-to-end manufacturing operations within our own production facilities.

Connectivity, consistency and control enable users to leverage the actionable data collected by Renishaw Central, and use it to exploit digital twin and Industry 4.0 technologies.

End-to-end process data capture provides insights for analysis and the improvement of manufacturing processes, enabling you to predict, identify and correct process errors before they happen.

Renishaw Central collects and provides visibility of machining process data across the factory for insights at the point of manufacture, to analyse and health check the performance of devices on the shop floor, examine device utilisation and part quality, and to sign off and validate the part. Renishaw Central data is accessible, visually engaging (via a series of dashboards) and supports in-process control applications and continuous improvement.



Connectivity: Connect sensors on machines across the shop floor.



Consistency: Monitor data from connected machines from a central location.



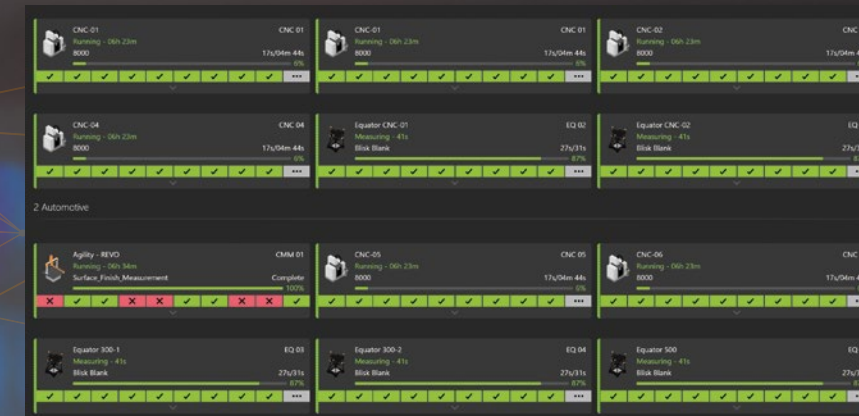
Control: Use collected data to update CNC controllers.

By standardising the flow of data to and from the modern, data-intensive shop floor, Renishaw Central makes it easy for a variety of systems and processes to access Renishaw device data and deliver a new level of operational efficiency. Up-to-date machine and job information, including metrology, machine status and alert data is made available to customers in several ways, including standards-based output (such as MTConnect®), the Renishaw Central application programming interface (API), and visualisation in web-based and mobile apps.



“ We’re delighted to be supporting our global customers with their manufacturing ambitions by helping them to bring their factory of the future ever closer. By connecting process, machine and part data from across the process chain, including additive manufacturing systems, on-machine measurements, shopfloor gauging and co-ordinate measuring machines (CMMs), the Renishaw Central manufacturing connectivity and data platform provides a clear view of a manufacturing facility’s process and metrology data – and that’s powerful. ”

Guy Brown, Renishaw Central Development Manager



Current Status dashboards display the latest quality measurements from your devices, including machine state, alerts and recent metrology. This draws your attention to issues you'll likely want to address.

Digitalisation of end-to-end manufacturing processes increases operational efficiency, reduces reliance on skills, improves ease of use and enhances decision making for process improvements.



www.renishaw.com/central

From our shop floor



Up to 1 million parts machined per month*

Welcome to our world. In this edition of Innovation Matters, members of Renishaw's highly experienced global manufacturing teams will be sharing their expertise. Steve Jay and Antony Spill work across two of Renishaw's world-class manufacturing facilities in the UK. Their jobs focus on improving manufacturing processes, using innovative solutions to reduce the process development time associated with low-volume small batch production.

Miskin, Wales



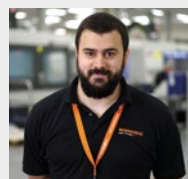
Demonstrating future smart factory concepts with current technology



Size: 460,000 sq ft



Personnel: 550



Steve Jay

Low Volume Production Group Leader

Stonehouse, England



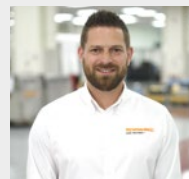
One of the UK's most efficient precision engineering operations



Size: 100,000 sq ft



Personnel: 220



Antony Spill

Low Volume Production Group Leader

Describe the low volume machining and piece part manufacturing operations at Renishaw

AS: Introducing efficient and 'low cost of quality' processes is our primary objective. *Low volume* is a separate entity to our main machine shop to help introduce new processes with very short lead times for custom and low volume products for all areas of the business.

Low volume production (LVP) machinists are responsible for the complete manufacturing process for new components, from introducing a new CAM process, to setting and running the machines.

Typically, we'll create a new process within an eight-hour shift, which includes using CAM software to create a new piece part program, setting the machine, and manufacturing the piece parts within these tight timescales. To achieve efficient processes with short lead times, we have to ensure our machines are in the best possible condition, which we do by carrying out regular health checks using Renishaw's QC20-W ballbar system. We rely heavily on Renishaw products to help maintain healthy machines we know are reliable and can produce correct components first time, every time.

When introducing new components, we focus less time on developing individual processes at the programming stage and more on developing procedures and processes where we know the machine tool is accurate enough to produce correct components every time.

Which Renishaw technologies do you enjoy using the most and why?

AS: I love a challenge and uncovering issues where we can pull together to implement a solution. We are solution providers and try to ensure this is embedded into everyone within the department. Finding new, innovative ways to use Renishaw products to improve our department



“ We rely heavily on Renishaw products to help maintain healthy machines we know are reliable and can produce correct components first time, every time. ”

is exciting and challenging, but having this technology at our disposal is invaluable.



What's the secret to successful low volume manufacturing?

AS: With a very high setting to running time ratio, it's imperative that we adopt quick processes from start to finish. This includes adopting programming methods that give confidence that the machine tool is accurate.

I've been targeting the error mapping of machinery to ensure the first component is correct without adding to the initial process development time.

One example of how we've achieved this involved a machine with extremely poor set time performance. To find out how we overcame this challenge, you can read the full interview online.

A recent example, and probably the most rewarding project I've been involved with to date, involved a machine that was almost classed as 'fit for the scrap heap'.

We used Renishaw technology to uncover genuine machine issues and implement a robust solution, which has given the machine a new lease of life.

SJ: Our additive manufacturing capability; the technology is brilliant. The way it challenges designers' imaginations, and the way in which we've introduced it as a productive workcentre within the department, is fantastic.



To read the full interview visit www.renishaw.com/IM22-interview

The total AM process chain

All additively manufactured components require a degree of finishing and inspection after they come off

the build plate. We are the only company in the 3D printing industry to offer the technologies and expertise that provide both highly productive metal 3D printing and control of finishing and downstream processes. Discover the total AM process chain, only with Renishaw...

Additive manufacturing offers the design freedom to produce intricate freeform components that are lighter in weight, higher performing, faster to build, more cost-effective and better adapted to their application than direct replacements or adapted designs.

You can design complex lattice structures to produce lightweight but structurally robust components, which is ideal for conformal designs that cannot be manufactured using CNC machining alone.

Part consolidation allows you to produce a single component that may previously have been formed by a larger assembly, requiring 'design for assembly', multiple parts and fastenings, higher material costs and extra weight. Assembly processes themselves can also introduce quality problems.

Our QuantAM build-preparation software takes the output from third-party software packages and processes those designs as 3D models ready to print. The processing functionality of our QuantAM software can even be embedded into the third-party CAD/CAM environment, allowing you to perform topological optimisation and then design efficient structural supports.



Once a final component and build process have been designed and validated using digital CAD software, a build-preparation file can be prepared offline and exported to the additive manufacturing system. We offer a range of technologies that surrounds our highly-productive RenAM 500Q metal 3D printing system, and supports efficient and cost-effective AM processes.



InfiniAM Spectral: This melt pool monitoring and analysis software provides feedback on energy input and emissions from the AM build process.



Renishaw Central: A single connectivity and data platform for additive and subtractive manufacturing operations.



QuantAM: Build-preparation software takes models generated in CAD/CAM and analysed and optimised with FEA tools and prepares them for build.



Equator™ gauging system: provides the confidence that you can move on to the next stage of the operation.

RenAM 500Q: Renishaw's quad-laser AM system for ultra-high productivity features four high-power lasers, which access the whole powder bed surface simultaneously for build rates up to four times faster than conventional single laser systems.

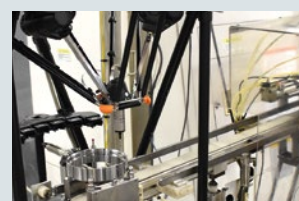


All complex freeform additively manufactured parts that come off the build plate require a level of downstream processing and finishing to achieve the desired surface finish or feature tolerance, and for mating features to traditional parts in an assembly, including sealing faces, bores and fixations. Only one company in the 3D printing industry offers end-to-end technologies and expertise that support the full AM process chain, and that's Renishaw.

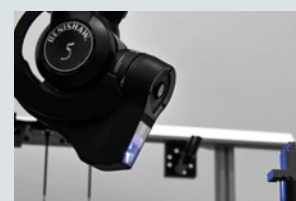
After machining, you need to know that your freeform part meets design intent and that your manufacturing process is performing as expected. Our industry-leading inspection technologies provide the confidence that the complex part you've manufactured meets your design intent with full process traceability.



REVO® 5-axis measurement system: this automated multi-sensor system provides contact and non-contact measurement probes for full inspection of parts and features on a single CMM, including surface finish measurement.



Equator™ gauging systems: fast, flexible shop floor gauging for repeatable inspection of features at the point of manufacture.



Non-contact probing technologies: finding a datum feature to work from can be difficult on curved or complex metal printed parts. Use our non-contact probing technologies to capture a 3D point cloud of the freeform surface.



SPRINT™ technology: high-speed, high-accuracy, 3D scanning machine tool probing systems capture the freeform surface of the part on the machine for fast part set-up and machining process control.



NC4+ Blue: high-precision, high-speed on-machine tool measurement and broken tool detection using blue laser light allows process control on all sizes and types of machine tools.



Renishaw Central and on-machine Reporter software: provides visibility of machining process data, which can be used to examine process performance over time and check whether you're within control limits.

The importance of data for AM

As your part goes from CAD design to AM build, to freeform printed part and onwards for post-process machining and finishing, data is captured at each

discrete production operation. This data provides evidence and an audit trail that your part has followed a prescribed process through production and that you have monitored process parameters and potential sources of variation. This end-to-end data and evidential process compliance is critical for emerging AM parts used in medical and aerospace industry

sectors. You can also use your data to create virtual representations of your products, production processes, or performance, in order to exploit closed-loop, end-to-end digital twin technologies. Real-world data collected and presented in Renishaw Central, for example, can enable comparison or benchmarking with the help of a digital twin.

To read more about our total AM process chain visit

www.renishaw.com/IM22-TotalAMProcessChain

Machine tool probing increases FMS productivity by 60%



Customer: Trevisan Macchine Utensili (Italy)

Industry: Energy

Challenge: To provide a Flexible Manufacturing System to produce valves with high precision and productivity, and minimal manual intervention.

Solution: Integrated machine tool probing systems for the measurement and verification of parts and tools.

Background

Founded in 1963, Trevisan Macchine Utensili (Trevisan), located in Italy, is recognised as a global leader in the design and production of stationary-part turning machines. They are used in a variety of industries, including aerospace, agriculture, automotive, energy and marine.

Trevisan has always been characterised by extremely high quality and engineering standards. Its machines are designed and manufactured in-house, ensuring complete control over each step of the production process.

Committed to continuous technological advancement, the company also offers customers complete state-of-the-art flexible manufacturing system (FMS) solutions, integrating multiple Trevisan machining centres, pallet management systems and automated tool stores.



One of Trevisan's longest-standing clients, a multinational provider of valves for the oil and gas sector, invited Trevisan to provide an FMS that could produce valves with high precision and productivity, with minimal manual intervention. Trevisan turned to an array of Renishaw machine tool measurement solutions to provide the enhanced levels of process control the system required.

Challenges

Trevisan's FMS proposal to its client comprised a production line of four of its DS600/200C machining centres, backed by a double-height, 40-place multi-pallet system and a robot-controlled 600-position tool store capable of tackling a range of metals including special steels, stainless steel, alloys and Inconel® alloys.

Working as the lead contractor, Trevisan engaged with Renishaw for the supply of measurement systems to control and verify parts and tools, as well as other specialist suppliers for the provision of the pallet-handling system and robotics. Trevisan had used Renishaw

equipment on its own machine tool production lines for many years, and the valve manufacturer approved of the choice.

For valves used in the international oil and gas sector, the quality of production is paramount. Not only do valves need to ensure the safety of workers, they are also relied upon to interrupt oil or gas flows without fail. Perfect tightness is an absolute fundamental requirement for a valve, since even the tiniest of cracks or the minutest of flaws can result in an escape of oil or gas that can pollute and endanger the surrounding environment.

Massimo Marcolin, Sales Director of Trevisan Macchine Utensili said, "To avoid any risk of hazards, valve manufacturing requires maximum precision. For the internal parts of the valve, where flow interception occurs in the core, we cannot allow the slightest inaccuracy. This would render the whole valve unusable."

Achieving the high levels of accuracy and part quality required presented a series of part and tool measurement and verification challenges:

- **Pre-process part verification and set-up:** determining the precise position of the raw part on a pallet, its exact dimensions and any stock allowance enables optimised roughing, milling and turning processes.
- **In-process part verification:** in-cycle measurement of machined features to verify and control performance.
- **In-process tool measurement:** automated checking of tool health, guarding against tool wear and breakage.
- **Finishing tool verification:** checking cutting tools for wear or damage prior to final finishing processes.

Marcolin explained, "The FMS is designed such that each valve is processed on a single machining centre, with the aim of producing a valve that's perfectly ready to be fitted and used. This requires that all of the finishing work is completed within the machine and means the finishing tool has to be perfect in its precision."

Solution

Inspection probe technology

Each raw part arriving at a machining centre on a pallet is measured automatically on the machine tool using a Renishaw RMP40 radio transmission spindle probe. This ultra-compact touch-trigger probe allows easy access to all part features, enabling repeatable measurement of part dimensions, position and alignment on the pallet within 1 µm accuracy.

The probing system communicates with the machine tool CNC via a Renishaw radio machine interface. Measurement results are used to align the part and work co-ordinate systems and set up the machine tool for precision turning, milling and grinding operations.

The RMP40 is also employed throughout the valve machining process for dimensional checks on roughed and finished features, to ensure process operations remain in control.

Non-contact tool measurement

With a part's dimensional accuracy dependent on multiple variables, including tool size deviation and run-out, accurate tool measurement and verification throughout the valve manufacturing process is a vital consideration.

To achieve the accuracy required, while maintaining fast machining centre throughput, Trevisan elected to use the Renishaw NC4 non-contact laser tool setting system.

Suitable for all types of machining centre, the NC4 system supports a wide range of operating gaps and configurations and features an integral air blast and MicroHole™ and PassiveSeal™ technologies to protect its precision optics. It measures and detects tools or features as small as 0.03 µm in diameter and to a repeatability of ±1 µm.



High-precision tool setting arms

Also part of the FMS's tool set-up operations, Renishaw's high-precision motorised arm (HPMA) was used for in-process tool measurement and broken tool detection on the finishing CNC lathe.

The arm is available for machine chuck sizes from 6 in to 24 in, with stylus configurations for all standard tooling sizes between 16 mm and 50 mm.

Results

By integrating Renishaw machine tool probing systems for the set-up and measurement of valve parts and cutting tools, Trevisan Macchine Utensili has created a flexible manufacturing system for its client that succeeds in maximising precision and productivity.

By automating previously manual operations, the FMS has eliminated both the risk of human error and the risk of scrappage caused by excessive tool wear or tool breakages. Measurements are made with greater accuracy without sacrificing production throughput.

Since operating the FMS at full capacity, the valve manufacturer has reported a significant increase in overall productivity of 60% and a defect count of zero. It is producing more high-precision valves for the oil and gas sector, more reliably and without any wastage.



www.renishaw.com/casestudies



We'll bring the exhibition to you

Explore our virtual exhibition stand – Virtual-Expo – to discover how Renishaw's smart manufacturing technologies can be used across a variety of industries, with the help of our new interactive 360° environment.

- Speak to an expert
- Request an online demo
- Access training and support

www.renishaw.com/virtualexpo

Renishaw plc, New Mills, Wotton-under-Edge, Gloucestershire, UK, GL12 8JR
© 2021 Renishaw plc. All rights reserved.



+44 1453 524524

uk@renishaw.com