Issue 2020

RENISHAW
apply innovation™

Innovation Matters

Benefit from the factory of the future, today

Manufacturers must produce parts to ever-closer tolerances to remain globally competitive.

Learn more about our smart factory technologies, inside.

In this issue:

Welcome to the REVO® revolution

REVO 5-axis measurement system brings dramatic speed and accuracy benefits to part inspection on CMMs.

Leading the way with SPRINT™ technology

High-accuracy machine tool scanning systems for rapid part set-up and machining process control.

All things additive

Discover how our additive manufacturing (AM) systems and software enable new levels of design freedom.

Helping you reach manufacturing excellence

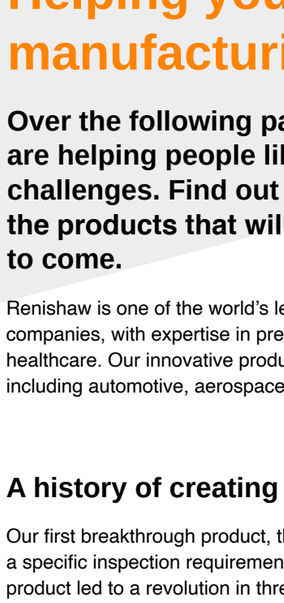
Over the following pages, discover some of the ways we are helping people like you solve a variety of complex challenges. Find out how we can help you to manufacture the products that will define our world in the years to come.

Renishaw is one of the world's leading engineering and scientific technology companies, with expertise in precision measurement, additive manufacturing and healthcare. Our innovative products serve diverse markets across various industries including automotive, aerospace and electronics.

A history of creating the future

Our first breakthrough product, the touch-trigger probe, was invented in 1973 to solve a specific inspection requirement for the supersonic Concorde's engine. This innovative product led to a revolution in three-dimensional co-ordinate measurement and the accurate measurement of machined components and finished assemblies.

Today, we have more than **80 offices in 36 countries,** and employ around **5,000 people worldwide**.



In this issue:

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Benefit from the factory of the future, today

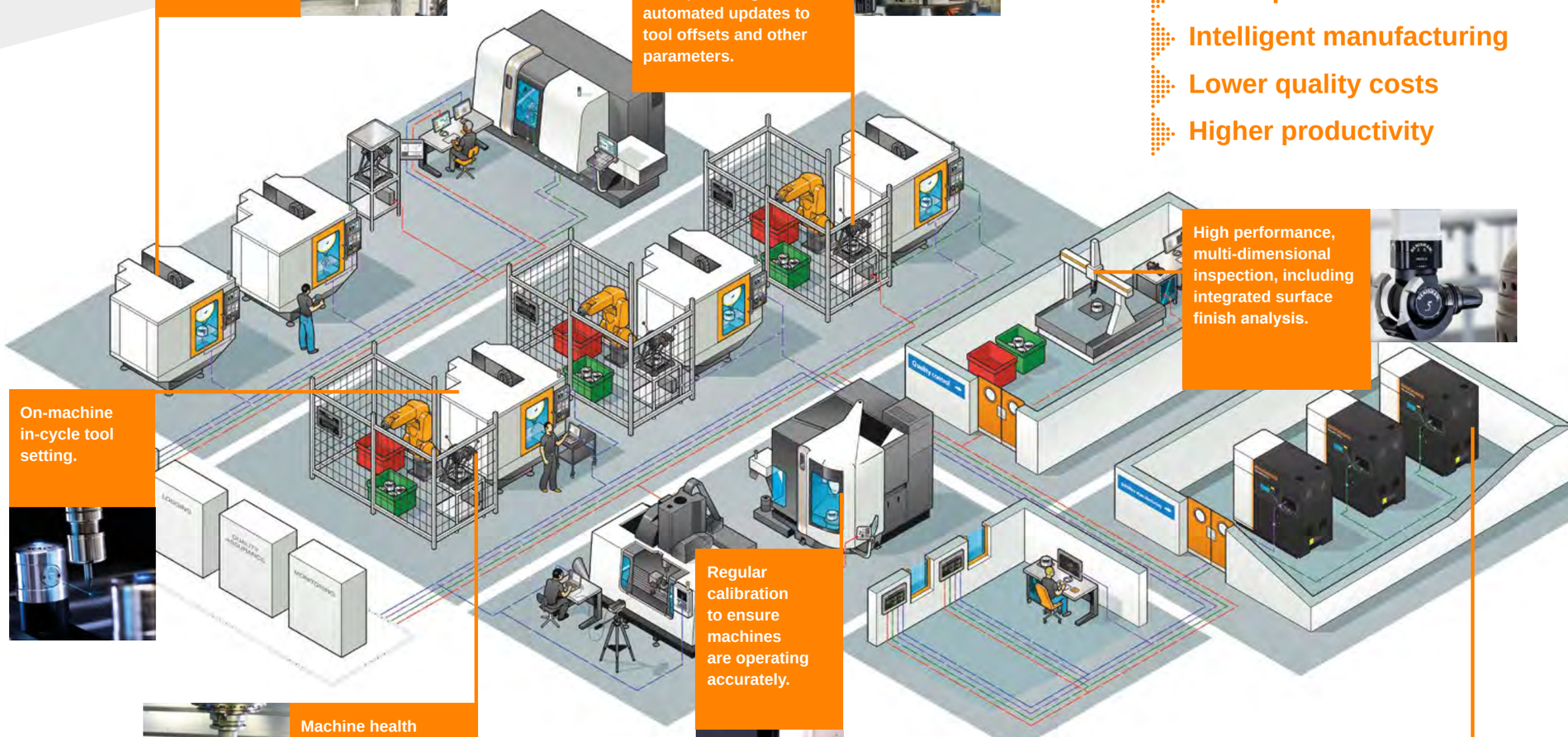
Manufacturers globally face challenging times with a variety of important drivers to address. These include the need for quick, flexible responses to consumer-driven demand for increased product variety, whilst also ensuring high levels of manufacturing precision.

‘Industry 4.0’ and the ‘smart factory’ are being widely discussed, whereby future machines and systems communicate with each other across a shop floor, share data and trends, and make decisions to ensure the production of high-quality parts by controlling sources of variation.

With Renishaw, that future starts now. Our diverse portfolio of technologies for smart manufacturing, including process automation and innovations in collecting and managing actionable data about devices, processes and parts, enables our customers to exploit Industry 4.0, and to benefit from the factory of the future, today.

Our range of smart factory process control solutions is proven to help machine shops across many industries transform their production capabilities. Benefits include high levels of automation, reduced human intervention, direct process control, intelligent manufacturing, lower quality costs and higher productivity.

- Highly automated
- Reduced human intervention
- Direct process control
- Intelligent manufacturing
- Lower quality costs
- Higher productivity



On-machine part setting and verification.

Highly repeatable, versatile and reprogrammable gauging on the shop floor, providing automated updates to tool offsets and other parameters.

High performance, multi-dimensional inspection, including integrated surface finish analysis.

On-machine in-cycle tool setting.

Regular calibration to ensure machines are operating accurately.

Machine health checks with Renishaw’s QC20-W ballbar system.

Metal additive manufacturing (AM) systems create topologically optimised parts and enable design freedom.

The importance of **data**

Smart factory concepts require connected control systems that are easy to use and provide measurement data immediately for self-correction and adaptation to sources of process variation. These control systems don’t only provide immediate process control feedback, they also generate crucial insights to help manufacturers make informed future decisions concerning factory and component conditions.

The integration of robust and connected sensors into manufacturing systems is critical to providing the data required for smart manufacturing. These include measurement probes, calibration devices and position encoders. Programmable sensors give manufacturers the flexibility to adapt to changing product and process requirements.

Renishaw’s remote process monitoring software for additive manufacturing (AM) systems monitors the progress of builds anywhere, with data used to show near real-time insight into live AM builds.

See p.22 for more information.

Introducing our own smart factory

For the past 25 years, Renishaw has been developing its own smart manufacturing capability. With this experience, and data generated from our RAMTIC automated machining platform, our 43,000 m² site in Miskin, South Wales, UK, is a shining example of a smart factory at work.

At Miskin, the integrated application of Renishaw technologies enables highly productive automated manufacturing, with minimal human intervention. We use our own products in our manufacturing processes which demonstrates our complete confidence in their performance. Indeed, each Renishaw product that is produced is measured and verified by another.

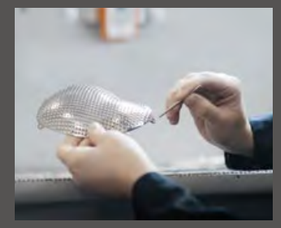
By integrating layers of precision measurement and automated inspection technology into production processes, our Miskin plant demonstrates an approach to future smart factory concepts that can be achieved with current technology, today.

Renishaw is the only company which builds metal additive manufacturing (AM) systems (also known as 'metal 3D printers') in the UK. Our specialist production lines at Miskin allow for these complex systems to be manufactured with confidence, meaning that our customers achieve high-quality production capabilities.

To find out more about Renishaw's additive manufacturing solutions, see p.20

> **"Although 'smart manufacturing' is being widely discussed as a current theme, Renishaw has been evolving and implementing smart factory principles successfully for over 25 years across our own manufacturing operations."**

Paul Maxted
Director of Industrial Metrology Applications, Renishaw plc



Healthcare Centre of Excellence

Also based at Miskin, Renishaw's Healthcare Centre of Excellence is a unique facility for the healthcare sector, showcasing the development of patient-specific implants, dentistry and neurosurgery.

The Centre contains a mock, non-sterile operating theatre for training and demonstrations, plus facilities for education, training, workshops and lectures. Additionally, there is a facility for the manufacture of class 3 custom medical devices, produced using Renishaw's metal AM machines, which operates an ISO 13485 quality management system.

To find out more about our work in the medical industry, visit www.renishaw.com/medical

Driving an automotive revolution

Today's automotive sector is increasingly consumer driven, so companies must adapt to keep up with the rising demand for product innovation.

This includes:

- **a new generation of powertrains for electric vehicles**
- **digital connectivity and on-board entertainment systems**
- **new and complex components and functionality**
- **vehicles with complex contours, which increases complexity of design and manufacture.**

Throughout the automotive supply chain, Renishaw helps manufacturers adapt to these challenges and evolve. We help develop their visions for future vehicle manufacturing, by supplying advanced metrology systems and sensors that enable smart factory concepts to be implemented with existing technology.

Keeping pace with changing powertrain requirements

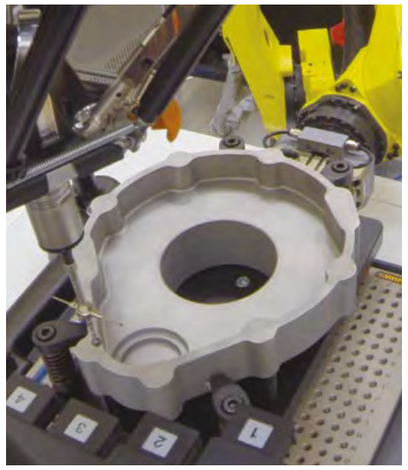
For decades, we've provided our expertise and technology to help manufacturers build their engines, gearboxes and drive train components. The result is powertrains that are more economical to produce, more reliable, and manufactured to higher quality standards – giving improved performance, greater fuel efficiency, reduced emissions and longer service lives.

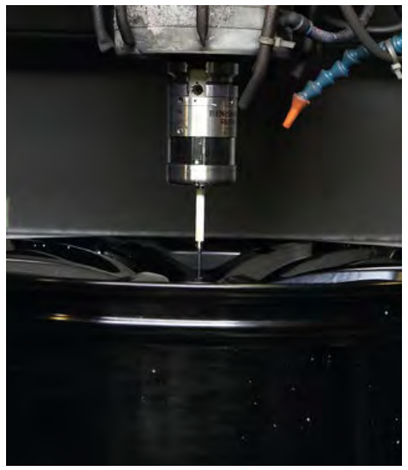
The greater complexity of modern engines and gear boxes imposes ever tougher form and dimensional requirements on parts. Efficiency and operating standards also demand precise control of the flatness, waviness and roughness of material surfaces. Our technologies are used to validate part conformance against these requirements.

Today, with the advancement of electric vehicles and other alternative powertrains, we are working closely with global manufacturers to ensure they can keep pace with a rapidly changing technological environment.

Controlling your processes

From calibrating machine tools and ensuring accurate set-up, to final inspection, we help ensure out-of-tolerance parts never reach final assembly of a vehicle.





> **Accuracy is the main reason we use Renishaw technology. I don't think we could do half of what we do without their probes.**
>
> Tridan Engineering (UK)

Electric vehicles – focusing on the road ahead

The way that vehicles are designed and manufactured is changing. The demand for electric vehicles is rising and the technology surrounding them is evolving rapidly; drivers are looking for excellent range, strong design values and, most importantly, the same high-quality feel of a traditional vehicle. The rise in vehicle mobility has also resulted in reliability and service life becoming even more important.

As a manufacturer in our own right, with a strong history of innovation, we are well placed to control the manufacture of precision parts and to offer solutions to real industry challenges:

- **Additive manufacturing and vacuum casting technologies for design, prototyping, and production applications**
- **Probe systems and software for job set-up, tool setting and inspection on CNC machine tools**
- **Laser and ballbar systems for performance measurement and calibration of machines**
- **Encoder systems for high-accuracy linear, angle and rotary position feedback**
- **Gauging systems for comparative measurement of machined and assembled parts**
- **Sensor systems and software for measurement on CMMs (co-ordinate measuring machines)**
- **Styli and fixturing for a wide range of measurement applications**
- **Raman spectroscopy systems for non-destructive material analysis**

For more information on our automotive industry solutions, visit **www.renishaw.com/automotive**

Aerospace innovation for over 40 years

Renishaw helps manufacturers undertake repeatable, traceable, efficient work, to the finest tolerances. We do this throughout the supply chain so that every component, not just safety critical ones, meets its design intent.

We provide solutions throughout the aerospace industry in many application areas and we have particular expertise in controlling the manufacture of blades and components for engines. We also offer expertise in controlling the manufacture of specialist components.

> **Inspection cycle time has been cut by 75%.**
> **Previously a manual measurement would be taken and recorded on paper; now, we have fully electronic reports with every dimension recorded. We can also use trend data to help identify potential areas for improvement in our manufacturing process.**
>
> **Senior Aerospace Weston (UK)**

Manufacturing performance

Improving the predictability of manufacturing to create a consistent and stable process improves the throughput and delivery performance of supply chains.

Maintenance, repair and overhaul (MRO)

Our measuring equipment delivers the extreme accuracy required to remedy blade wear and repair other components that demand high quality maintenance in service.

Safety

Improving the safety of components begins with quality. We are relentless in eliminating sources of variation, producing ever-finer measurement to increase the safety of components and delivering the highest standards of traceability.

Innovative materials

We're pioneering additive manufacturing (AM) solutions like lattice structures and part consolidation for lightweighting, complex internal galleries to optimise fluid flow, and design for AM to enable topological optimisation.

Engines and blades

Aircraft engine components demand some of the highest manufacturing standards in the world. We have decades of experience supporting the manufacture and maintenance of aero engines, delivering efficient, repeatable, traceable manufacturing processes for the most costly and difficult-to-machine materials.

For more information about our aerospace industry solutions, visit
www.renishaw.com/aerospace

CMM automation, speed and throughput – without compromising on accuracy

Renishaw has been applying innovation to the co-ordinate measuring machine (CMM) industry for more than 40 years.

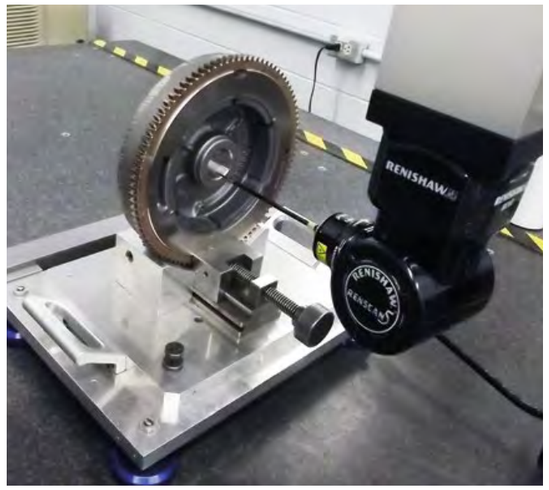
We have led the step-change in turning CMMs into multi-sensor platforms that feed critical process data back to the manufacturing process quickly, to enable process control.

REVO® 5-axis measurement system

Renishaw's REVO® 5-axis measurement system delivers high performance scanning, non-contact inspection and surface finish analysis on a single co-ordinate measurement machine (CMM).

The REVO system uses synchronised motion and 5-axis measurement technology to minimise the dynamic effects of CMM motion at ultra-high measurement speeds. It has multi-sensor capability – one REVO system can perform multiple tasks such as scanning geometry measurement, surface finish measurement and non-contact measurement for delicate parts.

Visit **www.renishaw.com/revo**



> **"The REVO scanning capability allows us to catch form errors much more quickly, without a time penalty on our inspections. It has definitely made us more proactive in catching quality problems early in the game."**
>
> Kawasaki (USA)

OPTiMUM™ diamond styli

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

The principal 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.

Visit **www.renishaw.com/styli**

QuickLoad™ rail system

Renishaw has developed the QuickLoad rail system for use with CMM applications. It allows for increased speed and flexibility, while maintaining repeatability and reproducibility when loading and locating base plates onto a CMM. The QuickLoad rail system will maximise your ability to inspect and release parts swiftly.

Using Renishaw modular metrology fixtures can improve the throughput, reproducibility and accuracy of your inspection process by providing quick and repeatable fixturing set-ups for your components.

Visit **www.renishaw.com/quickload**

Innovations for machine tool users

NC4+ Blue

A step-change in tool measurement accuracy

Featuring industry-first, blue laser technology and improved optics, Renishaw's NC4+ Blue systems deliver a step-change in on-machine tool measurement accuracy, with tool-to-tool performance proven to industrial standards.

Compared to red laser sources found in conventional non-contact tool setters, blue laser technology has a shorter wavelength, resulting in improved diffraction effects and optimised laser beam geometry. This enables the measurement of very small tools, whilst minimising tool-to-tool measurement errors – a critical consideration when machining with a wide range of cutting tools.

Visit **www.renishaw.com/nc4blue**

Machine tool software applications

We are committed to developing a range of machine tool software applications for our customers which make installing, configuring, using and maintaining our systems even easier:

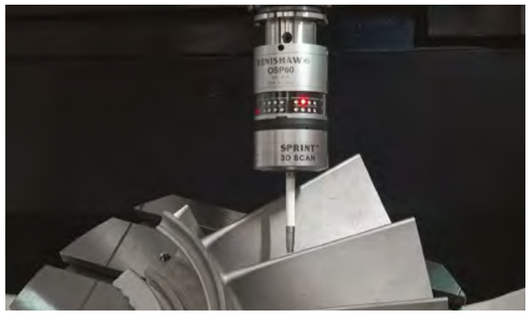
- On-machine apps can be seamlessly integrated with a wide range of CNC controls. Apps are installed onto a Microsoft® Windows®-based CNC control or a Windows tablet connected to the control via Ethernet.
- Smartphone apps provide information at a user's fingertips in a simple, convenient format. Available globally in a wide range of languages, our free-of-charge apps are perfect for new and less experienced users.
- With touch interaction and intuitive design, our smartphone and on-machine apps provide significant benefits to machine tool probe users across a variety of industries.

Visit **www.renishaw.com/machinetoolsoftware**

High-accuracy machine tool probes with RENGAGE™ technology

With unbeatable 3D measurement capability and submicron repeatability, Renishaw's family of machine tool probes with RENGAGE™ technology combines precise silicon strain gauge sensors with ultra-compact electronics to deliver superior performance. They excel in the measurement of complex shapes and contours.

Visit **www.renishaw.com/rengage**



Minimise cycle time, maximise productivity

A unique 3D sensor, Renishaw's OSP60 probe with SPRINT™ technology provides exceptional, high-speed, high-accuracy scanning for CNC machine tools. Exclusive benefits of using SPRINT™ technology include:

- Machine health check
- High-speed set-up
- Surface condition assessment
- 3D surface capture
- Adaptive machining

Visit **www.renishaw.com/sprint**

Innovations for machine builders

We have extensive experience of partnering with global machine builders and automation specialists to help them to significantly reduce the time taken to produce and inspect components, and to keep machines running reliably. We provide a range of metrology products including position encoders and calibration systems to support builders of machine tools, robotics, rotary tables, material handling systems and more.

Introducing the XK10 alignment laser system

Renishaw's XK10 alignment laser system has been developed for use during the build and alignment of machine tools, replacing the need for artefacts. It can be used on linear rails to ensure that they are straight, square, flat and level, as well as to assess spindle direction and coaxiality of rotary machines.

The XK10 can be used to measure and record a range of geometric error types using a single system. Live error readings allow adjustments to be made to the machine during the alignment process.

Visit **www.renishaw.com/xk10**

Performance in miniature – with the ATOM DX™ encoder series

Our range of position encoders ensures accurate linear and rotary motion control in a wide range of applications, from electronics, flat panel display and semiconductor manufacturing, to medical, precision machining, robotics and print production.

The ATOM DX encoder series is a range of high-performance encoders offering the smallest system size of any Renishaw digital encoder and also a top-exit cable option to maximise space-saving potential. The combination of miniature size, digital quadrature output direct from the readhead and Renishaw's market proven filtering optics, creates a powerful foundation for the building blocks of a motion system.

Visit **www.renishaw.com/encoders**

APCS-45 tool-setting probe – for the harshest environments

Engineered for the harshest machining environments found in lathes and multi-tasking machines, APCS-45 provides a robust, reliable and automated solution for setting a wide range of tools – such as turning, grooving, threading and boring tools. It enables manufacturers to implement automated tool measurement into turning and multi-task machining applications.

These measurements can be used for initial tool setting, tool replacement cycles, tool wear, tool breakage and thermal growth monitoring.

Visit **www.renishaw.com/apca45**

Quick and easy to use software for laser measurement

The CARTO suite is made up of two applications: Capture to collect laser interferometry data and Explore to provide powerful analysis to international standards.

It guides users through the workflow of the machine measurement process, from setting up a test to analysing data. Its intuitive user interface and the flow of the software matches the easy set-up of Renishaw's XM-60 multi-axis calibrator and XL-80 laser interferometer.

Visit **www.renishaw.com/carto**

Case study

Raising the bar on rotary table accuracy - Matsumoto Machine Corporation (MMK) of Japan

CNC rotary tables play a vital role in the performance of multi-axis machining centres. As table accuracy and reliability are of paramount concern throughout the product's lifetime, MMK has taken a pragmatic two-pronged approach to reducing indexing errors and improving performance.

By enhancing both product calibration and encoder technologies, the company has set new standards for rotary table accuracy.

Challenge

To reduce the indexing errors in CNC rotary tables.

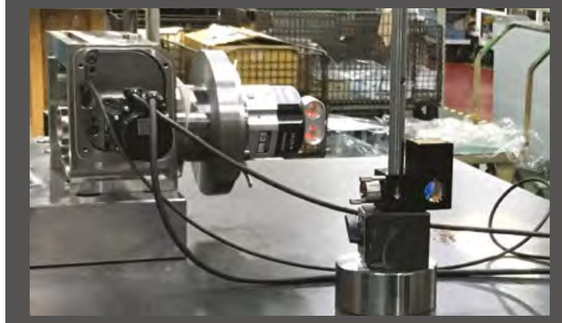
Solution

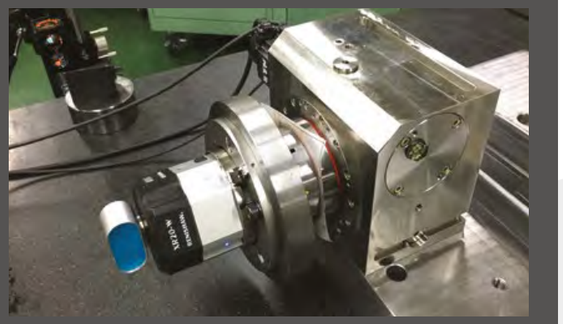
Using Renishaw's XR20-W rotary axis calibrator for performance verification and the integration of Renishaw's TONiC™ optical encoder and RESM ring scale.

Results

The introduction of Renishaw's XR20-W rotary axis calibrator has reduced product measurement times by 50%.

Integrating Renishaw's TONiC non-contact optical encoder system into its CNC rotary tables has further assured the accuracy and reliability of MMK's products in the field, along with an overall superior motion control performance.





Flexible Concepts Inc. and Renishaw's Equator™ shop floor gauging system

Customer:
Flexible Concepts Inc., Indiana, USA.

Challenge:
To perform all gauging on one common device and offer customers guaranteed machining capability.

Industries:
Predominantly automotive, but also heavy equipment and defence.

Solution:
Integrated Renishaw Equator gauging systems with automatic part loading and offset updates sent direct to high volume turning centres.

Flexible Concepts Inc. is a large automotive supplier based in Elkhart, Indiana, USA. As a big turning subcontractor with 175 Okuma 4-axis CNC lathes, its main business is high volume precision manufacturing. It set itself the challenge of being able to offer customers guaranteed machining capability, as part of a strategic decision to use innovative engineering to progressively increase the size of its business.

Meeting production needs with automation and direct process control

Flexible Concepts has integrated eleven Renishaw Equator systems to date, with automated part loading and offset updates, alongside selected Okuma turning centres.
For example, on a cell producing high volume turned parts for automotive transmissions, the Equator system gauges every part, with a combination of rapid touch points and fast scans, in a cycle time of 36 seconds. These high volume turned parts, with increasingly demanding tolerances, come with requirements to meet quality standards for feature size and position, on 100% of parts.

The gauging data is used, when necessary, to generate feedback to the machines, providing direct process control that keeps the process well within tolerance.

> **"I still have not seen a successful system out there that comes anywhere near Equator.**
>
> Tim Gerstbauer, Head of Engineering and Vice President at Flexible Concepts Inc. (USA)

Gauging a wide variety of tolerances

That's not the only reason the Equator gauging system suits this manufacturing process so well - Tim Gerstbauer, Head of Engineering and Vice President at Flexible Concepts, stresses another important function, "The biggest advantage by far is that the Equator system can also watch the geometric tolerances - these are difficult to control unless you can see them directly. Equator allows us to do that."

With previous techniques it was difficult to check these geometric tolerances in production. Now all of these features can be monitored, with roundness being particularly important. Even perpendicularity and parallelism can be checked, without needing to visit the quality room.

Implementing the flexible gauging process

Matt Kratzer, Flexible Concept's IT Manager, worked with Renishaw for about two months to develop the whole process. "We worked with Renishaw's engineers to get the cycle time of the Equator to match the machine cycle time, which was very low."

"Renishaw also worked with us on the feedback for the Okuma machines – an average is done on every third part, to keep the tolerances", explains Matt.

The update values, if and when required, are constantly calculated and fed back to the Okuma control automatically, without any operator intervention. This brings consistency, without any chance of human error, and removes the need for extra operator time on a tedious task.

Quality control with automation

Even though the project deadlines were fast approaching, the Equator programming and automation setup was done in a matter of weeks. This involved development and testing of the gauging program, along with integration of a conveyor and simple fixturing. There have now been more than two years of reliable service, with the gauging process running consistently since it was introduced.

A real sucess story

Tim Gerstbauer sees Renishaw's Equator gauging system as a key part of the company's drive for high quality and efficiency. "Now we have 'machine-side', ongoing, real-life inspection," he explains, "plus, we've been able to automate it to the point where it runs itself. This has meant there is very little scrap or any issues with controlling the quality of the parts going out the door. Our customers are happy with this - it has removed any problems. I don't know how I would be able to do this successfully without Equator. Frankly, I still have not seen a successful system out there that comes anywhere near Equator".

Automated process control with the Equator™ gauging system

The Equator gauging system can provide closed loop feedback to update offsets directly on machine tool controls.

The gauging results can be easily read in real-time by Intelligent Process Control (IPC) software, which:

- **offers the ability to connect to a range of machine tool controls**
- **allows offset values to be updated, enabling true automated process control**
- **provides data that can be used to automatically compensate for common causes of process instability, such as tool wear and thermal drift.**

Visit **www.renishaw.com/gauging**

LESS WASTE, MORE SPEED

Explore a world of possibilities with AM

Additive manufacturing (AM) introduces new design possibilities for metal parts, including opportunities to combine multiple components in production, minimise material use and reduce tooling costs. Also called 3D printing, AM is a process used to create three-dimensional parts from a digital file. It usually involves building up, or solidifying, thin layers of material to create complete parts. The technology enables the production of complex shapes which cannot be produced by ‘traditional’ techniques such as casting, forging and machining.

Visit **www.renishaw.com/additive**

Why Renishaw AM?

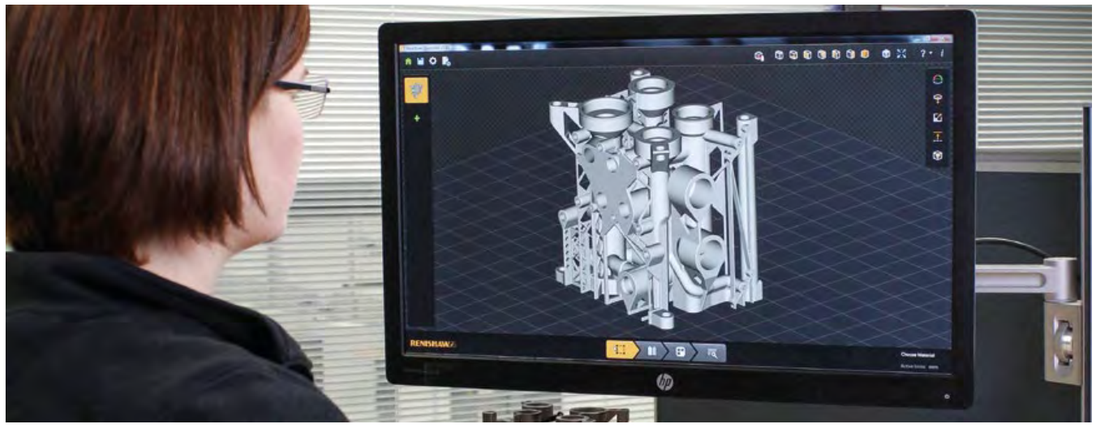
- **Less waste - integrated powder sieving and circulation system**
- **More speed - 4 x high-power 500 W lasers**
- **No requirement for tooling**
- **Increased design freedom - complex geometries and hidden features**
- **Rapid design iterations right up to manufacture**
- **Remote process monitoring software for near real-time insights into live AM builds and access to historic build analysis**
- **A global network of AM Solutions Centres staffed by experienced engineers**

Discover our AM software solutions

InfiniAM Central is Renishaw's AM remote process monitoring software. This Industry 4.0-ready, connected system, enables remote monitoring of AM build processes on computers and mobile devices, including near real-time insights into live AM builds and access to historic build analysis. System sensor and build information is displayed in graphic form to enable intuitive in-depth analysis.

QuantAM is a dedicated file preparation software tool for Renishaw's AM systems. With an intuitive workflow and easy navigation, QuantAM accepts CAD exports in the form of .STL data and allows you to prepare your model for the AM process. It can also be used as a tool to guide your Design for Additive Manufacturing (DfAM) process, helping you unlock the benefits of AM.

Visit **www.renishaw.com/amsoftware**



Case study

Powering the future of metal AM at Sandvik

Renishaw has collaborated with Sandvik Additive Manufacturing to supply the company with its high productivity multi-laser RenAM 500Q systems, which will substantially increase Sandvik's printing capacity.

This is one of the largest installations to date of the RenAM 500Q. The system features 500 W quad lasers in the most commonly used platform size, enabling a radical increase in productivity, without compromising quality.

To watch our Sandvik case study video and to find out how AM can power your operations, visit **www.renishaw.com/amguide**

> **"Sandvik has a leading position within the AM metal powder market and has made sizeable investments in different AM printing process technologies for metal components since 2013. The recent addition of Renishaw's multi-laser RenAM 500Q systems will complement our current printing portfolio in a very good way."**
>
> Sandvik Additive Manufacturing (Sweden)

Explore AM's potential at our Solutions Centres

Equipped with the latest AM systems and staffed with knowledgeable engineers, Renishaw's global network of Solutions Centres offer you a fast, secure and accessible way to rapidly deploy this exciting technology within your business.

Renishaw will support you throughout your investigation and business case development process, helping you to optimise your design, build your confidence in the process, and gain the evidence you need to make investment decisions.

To find out how our AM Solutions Centres can benefit you, contact your local Renishaw office at www.renishaw.com/contact

RENISHAW
apply innovation™

Take control of your manufacturing process

Intelligent machining processes are a critical element in advanced manufacturing technology. Widely publicised trends such as Industry 4.0, the Industrial Internet of Things, cloud computing and data mobility provide manufacturers with an unparalleled opportunity to develop processes which deliver improved productivity and process capability.

Renishaw provides the technologies required to measure and control many of the key process variables in CNC machining and other forms of manufacturing.

Talk to us about how we can help transform your manufacturing.

www.renishaw.com