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Unlock the hidden potential of your CMMs

Measurement is vital to any manufacturing business, providing essential information to control processes and verify products. But older co-ordinate measuring machines (CMMs) can become bottlenecks if they fail to keep pace with changing measurement needs. Advances in sensor, metrology software and controller technology now offer the opportunity to transform existing CMMs, providing greater accuracy, faster measurement, more automation and new capabilities, whilst taking full advantage of CAD-driven programming. In the current economic climate, upgrading makes good economic and ecological sense.

Get more from your CMM

The most advanced technology developments in sensors, controllers and metrology software have transformed the performance of new CMMs. As these advances are not dependent on the CMM frame, they are also available on your old CMM, giving you …

- **more capability** with simple, fast and intuitive CAD-driven programming and graphical reports that are easier to interpret

- **more throughput** using the latest scanning sensors and motion control technologies

- **more information** about your parts with automated multisensor measurement

- **more profitability** with reduced maintenance and support costs

- **more confidence** that your CMM is equipped to meet your future measurement needs

Most CMM structures are not subject to high levels of wear and so remain serviceable for many years. What's more, because you are re-using the costly superstructure of the machine, an upgrade is a fraction of the price of a comparable new machine.

A measurement revolution

The award winning REVO® 5-axis scanning system provides unprecedented performance on both new and existing machines. REVO measures using 5 axes of simultaneous motion and enables even old machines to …

- **measure faster** at speeds of up to 500 mm/sec, which can be 50 times faster than 3-axis scanning

- **measure more** points at up to 4,000 points per second, giving a better understanding of component form

- **measure more** accurately by eliminating dynamic errors using 5-axis techniques

- **measure more** features using infinite sensor positioning for unparalleled flexibility

- **measure without compromise** by using radically shorter cycle times to enable 100% inspection for optimum verification and process control

The operational benefits this brings are as follows:

- reduced measurement cycle times

- elimination of CMM bottlenecks and rapid process feedback

- high speed head and sensor calibration increases uptime

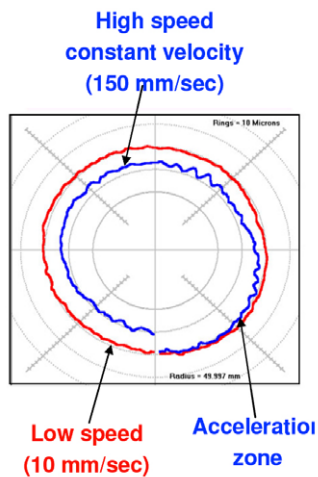- less time spent indexing and stylus changing, resulting in more time spent measuring

5-axis scanning technology is revolutionising CMM inspection.

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Breaking the dynamic performance barrier

The first generation of computer-controlled CMMs were developed to suit touch-trigger probing, in which discrete points are acquired at key locations on the component. The measurement process involves driving the probe's stylus onto the surface of the part at a constant speed, so the CMM's structure is not accelerating when a measurement is taken. This means that machines did not need to be particularly stiff to measure accurately.

The arrival of 3-axis scanning drove changes to the design of CMM structures. Scanning involves moving the stylus of the probe across the component, following its surface contours. For instance, measuring a feature such as a hole requires the probe to be moved in a circular path, causes the moving elements of the CMM structure (the bridge and quill) to undergo accelerations whilst the measurement is taking place. These structures are large and heavy, so accelerating them requires significant forces and inevitably results in inertial deflections at the stylus tip that are not seen by the machine's position encoders which are located, in the case of the Y axis, on the bed of the machine.

These inertial forces twist and deflect the machine structure, resulting in measurement errors that can quickly become larger than the measurement tolerance (see below). Sadly, the laws of physics dictate that, when measuring holes, the inertial forces increase with the square of the measurement speed, so going faster becomes increasingly difficult, despite the best efforts of machine designers.

This chart illustrates the impact of scanning speed on measurement accuracy. Two scans are taken on a calibrated ring gauge at different speeds.

The low speed plot (red) shows little form error, whilst the high speed plot (blue) shows a rising error as the radial acceleration builds up as the machine attains the programmed scanning speed. The feature appears too small due to outward radial deflection of the CMM structure as it undergoes inertial forces whilst following the circular contour.

Even the fastest modern machines are limited to scanning speeds in the region of 80 to 150 mm/sec, depending on the nature of the feature being measured. But practical concerns about accuracy (illustrated above) mean that most scanning in production applications is done in the 10 to 25 mm/sec range.

5-axis scanning breaks through this barrier by avoiding the problem of machine dynamic errors. Instead, the innovative REVO scanning head is able to acquire surface data whilst moving its 2 rotary axes at up to 3 revolutions per second, enabling scanning speeds of up to 500 mm/sec, far beyond the capability of even the fastest CMMs. The apparently insurmountable problem of dynamic errors is alleviated by not asking the machine to accelerate during measurement, or at least minimising such acceleration where it cannot be avoided altogether.

This is achieved by using 5 axes of simultaneous motion, with the bulk of the workload of moving the stylus tip falling to the REVO head. Examples of these new techniques are illustrated below:

Touch-points   **Circle scan**

Sweep scan

Helical scan   **Gasket scan**

Section scan

Controlling factor

The motion controller is a vital factor governing the performance of any CMM. An outdated controller can limit the range of measurements that can be taken, and may eventually become unsupported and unreliable. In short, it can cripple a perfectly good CMM frame, or at least limit its ability to meet your changing needs.

Renishaw's UCC family of controllers has been specifically designed to suit retrofitting with 'plug and play' installation on most models of CMM. Versions supporting touch-trigger, 3-axis scanning and 5-axis scanning provide an upgrade path for customers as their needs evolve. In addition to seamless integration of a wide array of sensors, the controllers feature advanced motion control techniques that allow rapid movement around the part and smoother, faster scanning.

UCC controllers are I++ DME compliant, enabling you to choose the software that best suits your needs, and even change software to suit different inspection tasks.

Improving automation

5-axis scanning is best suited to the measurement of complex parts where inspection cycle times are currently long, or where large volumes of components must be measured and throughput is a principal concern. In other instances, upgrading to a 3-axis scanning sensor or to a trigger probe with stylus changing can provide significant productivity and automation improvements at a lower cost.

Flexible, modular sensors and indexing heads can increase measurement flexibility and automation, providing access to all component features in a single set-up.
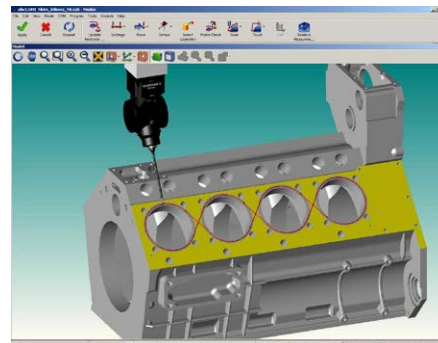
The power of CAD

Software is perhaps the biggest single reason why many CMM users choose to upgrade, as it is the aspect of the CMM that they interact with most often. Slow programming, clunky program execution, unfriendly reporting and outdated operating systems can all lead to frustration and harm productivity.
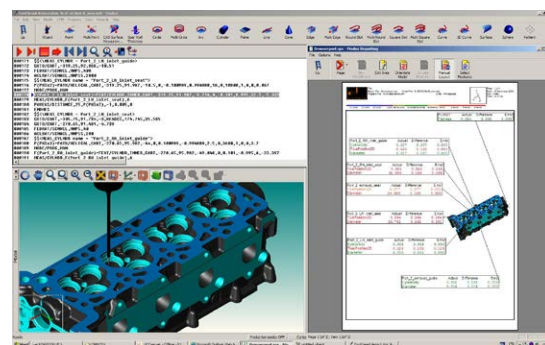
Modern metrology software is designed to make full use of the power of CAD, enabling rapid off-line programming with nominal and tolerance data coming straight from the model. Reporting is now graphical rather than tabular, making it far easier to interpret measurement data and, more importantly, take appropriate action as a result.

Renishaw's new MODUS™ software is a good example of this trend, built on industry standards such as the DMIS programming language and I++ DME communication protocol with the CMM controller.

Performance enhancing features such as sophisticated error mapping and temperature compensation are also available.

CAD-driven programming reduces development time and can be done offline, boosting CMM productivity.

Graphical reports are far easier to interpret than reams of tabular data.

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Upgrade and save

In the current challenging economic climate, making the most of your assets makes perfect sense. It is also good for the environment to continue to re-use serviceable elements of your CMM structure such as the bed, bridge and quill, whose manufacture is relatively energy-intensive.

Cost-effective upgrades to key elements of your machine – sensors, controller and software – can reveal your CMM's hidden potential, giving you state-of-the-art performance as well as a future-proof metrology system.

One-stop retrofit service

Renishaw's comprehensive retrofit service includes:

- New MODUS™ CAD-driven metrology software

- Future-proof CMM controller

- Unparalleled choice of sensors from TP20 touch-trigger to scanning with the SP25M or revolutionary REVO 5-axis technology

- UKAS-accredited calibration

- 12 months total machine warranty

- Rapid exchange service on all system elements

- Direct hardware and software support from Renishaw.

For more information, visit
www.renishaw.com/cmmretrofit

Renishaw provides a professional retrofit service, replacing all performance-critical elements of your CMM with innovative new technology.

5-axis scanning allows fast, seamless inspection of complex components, without pauses for indexing and stylus changing.