RENISHAW
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The Renishaw QC20-W wireless ballbar for machine tool performance diagnosis

Helps ensure accurate parts, first time, from CNC machines

Reduces down-time & costs

Reduces machine down-time, scrap and inspection costs

QA compliance

Show compliance with both machine performance and quality management standards

Predictive maintenance

Allows fact based predictive maintenance

Production pressures!

If you are involved in component machining you don't need telling that machining errors can result in numerous quality problems and reworked or scrapped components.

The quality of every component produced on a CNC machine is highly dependent on the machine's performance. Problems with a machine inevitably result in defective parts. It may be cosmetic, out of specification, or unfit for purpose but the inspection, investigation and rectification will have an impact on your business:

- Wasted time and reduced productivity
- Higher piece part costs
- Delayed deliveries
- Dissatisfied customers

All too frequently, traditional quality and inspection procedures only identify problems after components have been produced. That's too late.

This is especially true if you're working on high cost, complex parts. In combination with the close tolerances of the parts and high volume machining there is little or no margin for errors.

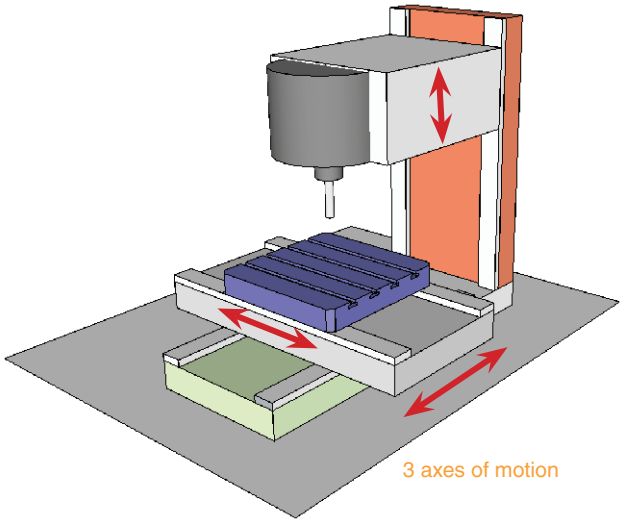
Human error and tooling problems can be some of the many reasons for this, but machine positioning performance can often be the major factor.

Modern CNC machine tools have excellent specifications, but their performance (even when new) can be compromised by inadequate foundations, poor location and incorrect installation. Once in use, they are also subject to wear and possible damage from crashes or misuse.

That's why it is ESSENTIAL that your machine's performance is checked regularly and, just as importantly, checked **before** you start manufacturing components.

Defective machines = defective parts

A typical 3-axis machine tool is subject to 21 degrees of freedom (deviations from the ideal including linear positioning, pitch, yaw, straightness, roll and squareness to the other axes). All of these can have a detrimental effect on the machine's overall positioning accuracy and the accuracy of machined parts.



3 axes of motion

Potential errors on an axis	
Backlash	Cyclic error
Reversal spikes	Straightness
Lateral play	Scale error

Potential errors between axes	
Servo mismatch	Squareness

. . . and multiple potential positioning errors on each axis (and between axes)

Furthermore, the potential for problems increases significantly when you consider the additional dynamic effects as the machine moves and the coordination needed to produce smooth, interpolated motion.

Degradation of machine positioning accuracy is not always apparent until a machine starts to produce reject parts. What is needed is a process to put you back in control of your machine tool so you can decide whether a problem needs immediate attention or can be tackled later, but in all cases, **before** you start machining!

With so many factors involved, any solution has to be simple to use, quick and deliver easily understood results, with the minimum disruption and cost to your business. Luckily there is a solution.

In theory if a CNC machine's positioning performance was perfect then the circle traced out by the machine would exactly match the programmed circular path.

Perfect circles in X, Y and Z axis define a perfect machine

In practice any of the errors mentioned above will cause the radius of the circle to deviate from the programmed circle. If you could accurately measure the actual circular path and compare it with the programmed path you would have a measure of the machine's performance.

This is the basis of the Renishaw QC20-W ballbar, the industry standard for quick machine tool performance diagnosis.

The Renishaw ballbar

Renishaw's QC20-W ballbar offers you the perfect solution. It's the quickest, easiest and most effective way to monitor machine tool condition.

The heart of the system is the ballbar itself, a very high accuracy, telescoping linear sensor with precision balls at each end. In use the balls are kinematically located between precision magnetic cups, one attached to the machine table and the other to the machine spindle or spindle housing.

This arrangement enables the ballbar to measure minute variations in radius as the machine follows a programmed circular path (see main illustration below).

The data collected is used to calculate overall measures of positioning accuracy (circularity, circular deviation) in accordance with international standards such as ISO 230-4 and ASME B5.54, or Renishaw's own analysis reports. Data is displayed graphically as well as in numeric format to aid and support diagnosis.

Supplied as a complete kit-in-a-case, the ballbar kit provides a powerful and portable solution – just add a PC and you're ready to start testing.

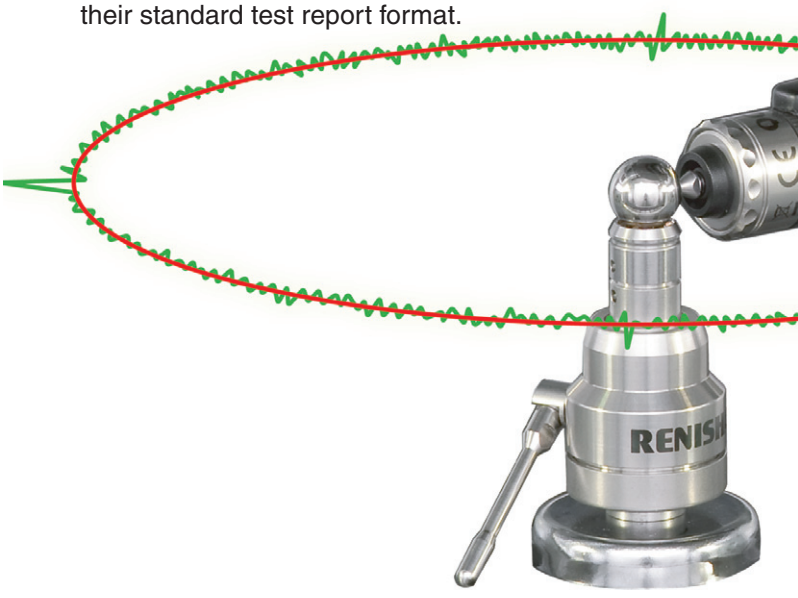
Renishaw ballbar testing

Typically, a quick 10 minute test is all that is required.

Ballbar 20 software guides you through the circular test described above, with clear information and guidance throughout the simple four step process

1. Set-up
   - Quick and easy, the QC20-W ballbar is mounted between two repeatable magnetic joints.
2. Capture
   - The machine performs two consecutive circular arcs (clockwise and counter-clockwise) in any one of the machines test planes (XY, YZ, ZX) and very accurately measures any variations in the test circle radius traced by the machine during the test.
3. Analyse
   - Renishaw's Ballbar 20 software then analyses the measured data to give results in accordance with various international standards (eg. ISO 230-4, ASME B5.54).
4. Diagnose
   - Renishaw's own and uniquely comprehensive diagnostic report also gives you an overall assessment of machine performance (circularity) but in addition provides an automatic diagnosis of up to 15 specific machine positioning errors. Each error is ranked according to its significance to overall machine performance alongside the error value. Even non-experts can get expert results.

     It is such a powerful diagnosis that many of the world's leading machine tool builders and manufacturing companies choose it as their standard test report format.



As simple as A-B-C

Fixing your machine

The Renishaw diagnosis report (a) not only ranks individual machine errors but using the “hot links” to the system manual you can see typical machining faults (b) related to these, and even some possible fixes.

Even with this diagnosis you can be faced with many alternative strategies to get your machine within the required specification. Your choice will depend on the machine configuration and what resources you have available. However, using an integrated simulator package you can use the results file to see what combination of error fixes will produce what overall improvement in machine performance.

This allows you to make an informed decision on the best course of action, whether that is in-house correction, contracted-in machine maintenance, or even moving production to an alternative machine.

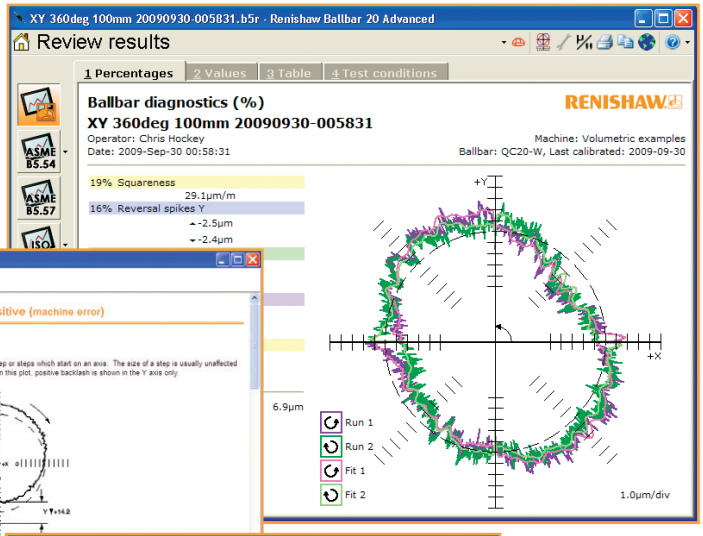
Advanced diagnosis

The QC20-W and Ballbar 20 software allows you, for the first time, to carry out testing in three orthogonal planes with only a single set-up. This gives much quicker testing and allows for a true “volumetric” analysis of your machine.

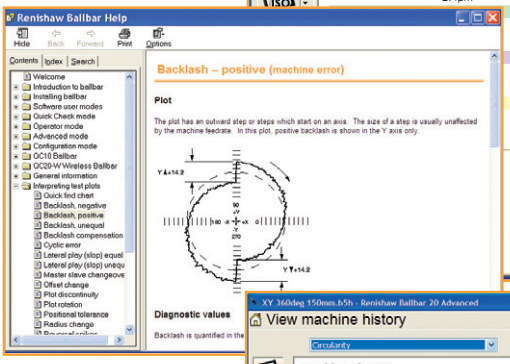
Checking trends

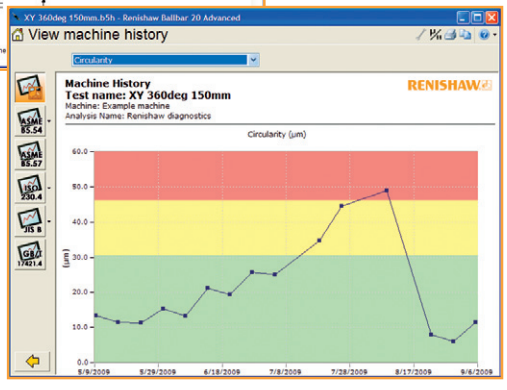
Regular, repeatable testing is the key to effectively tracking changes in machine error sources over time. Ballbar 20 uses customer defined test templates to ensure repeatable testing. A comprehensive machine history function (c) then gives you a quick and simple way to examine the data. You can see if problems are developing and so schedule preventative maintenance (PM) if necessary in a targeted and timely way. Fixing problems before they become critical minimises downtime and maintenance costs.

(a)



(b)



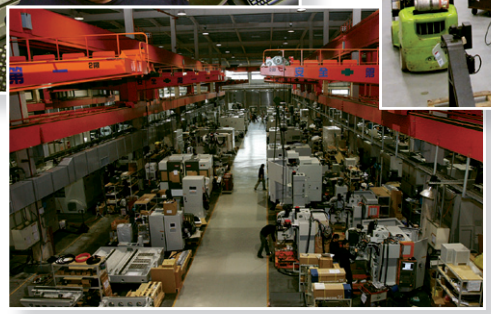


(c)

Whatever the type of company you work for

End user

Distributor



Machine OEM

Service and maintenance contractor

Whatever your job

The ability to quickly verify machine performance is of benefit across nearly all job functions.

- **Production**
  - Understand your machines' true capabilities, choosing the right machine for each job.
  - Achieve manufacturing tolerances, reducing or avoiding scrap, rework and time-consuming set up and inspection processes.
- **Maintenance**
  - Identify problems quickly; no need to strip down machines just to see if something is wrong.
  - Evaluate repair strategies and their results before you start.
  - Implement predictive maintenance programs by regularly tracking a machine's performance.
  - Minimise specialist "call outs" and check that contractors have fixed the problem before they leave.
- **Purchasing**
  - Evaluate new machines prior to purchase.
  - Evaluate after installation, before final sign-off.
- **Field service**
  - All the benefits as for "Maintenance" plus ..
  - Reduced warranty costs due to improved diagnosis.
  - Increased service team productivity due to reduced time on site (due to quicker diagnosis).
  - Increased customer satisfaction, test reports provide tangible proof of service.
- **Quality**
  - Comply with standards for quality management (eg ISO 9000).
  - Equipment calibrations traceable to national standards.
  - Ensure equipment meets recognised standards before shipment (machine tool OEMs).
- **Management/Sales and Marketing**
  - Reduce component costs, increase capacity and demonstrate your confidence and capability to your customers.

The Renishaw QC20-W ballbar helps you do your job better and saves you money

Implementing Renishaw ballbar

QC20-W ballbar kit

The system comes in a self contained kit including almost everything you need to begin ballbar testing. Just add a desktop, laptop or even a netbook PC. Accessories are available to extend capability to many lathes and two-axis machines (e.g. vertical turning lathes). As with any Renishaw product you have the support of our sales engineers, optional training courses and the back up of a world class service network.

QC20-W ballbar kit with Zerodur® calibrator

Proven in use

The Renishaw telescoping ballbar has been in use for over 20 years and is the most widely accepted tool for machine tool performance measurement. With thousands of ballbars in use worldwide, companies of all sizes and types have found them to be a cost-effective solution to improving their business. Whether it's a one man service operator or the largest of machine tool OEMs, the result is the same.

Why walk away from success?

The Renishaw ballbar is unique, simple to use and delivers real benefits for your business. If you own CNC machine tools you need the assurance of running regular ballbar checks. And now, with QC20-W, there's even more reasons to try one yourself.
Why walk away……. ?

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About Renishaw

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Since its formation in 1973, the company has supplied leading-edge products that increase process productivity, improve product quality and deliver cost-effective automation solutions.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

Products include:

- Dental CAD/CAM scanning and milling systems.
- Encoder systems for high accuracy linear, angle and rotary position feedback.
- Laser and ballbar systems for performance measurement and calibration of machines.
- Medical devices for neurosurgical applications.
- Probe systems and software for job set-up, tool setting and inspection on CNC machine tools.
- Raman spectroscopy systems for non-destructive material analysis.
- Sensor systems and software for measurement on CMMs (co-ordinate measuring machines).
- Styli for CMM and machine tool probe applications.

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