

Faster cylinder head inspection with REVO® 5-axis multi-sensor CMM system

The need for speed

Manufacturers of petrol and diesel cylinder heads used in conventional or hybrid vehicles have to control many features during the manufacturing process. Some features, such as valve seats and guides, have complex tolerances designed to ensure that engines perform efficiently, meet emissions regulations and reach their design life without breakdown.

This application note examines real life applications where high-volume engine manufacturers have benefited from the use of 5-axis inspection technology to transform their manufacturing process and both save cost and improve efficiency in large volume production environments.

To verify that each feature is within tolerance, a sample component is taken from the production line, typically every 200 - 300 parts or just after a cutter change in the machine tool. A co-ordinate measuring machine (CMM) is commonly used to check dimensions and form, whilst surface finish

measurements have traditionally been performed by an operator at a separate station using a range of handheld gauges. This two-step process adds time and requires increased resources to complete the part quality inspection.

The cost of quality

The overall cost of cylinder head inspection is directly related to three main elements:

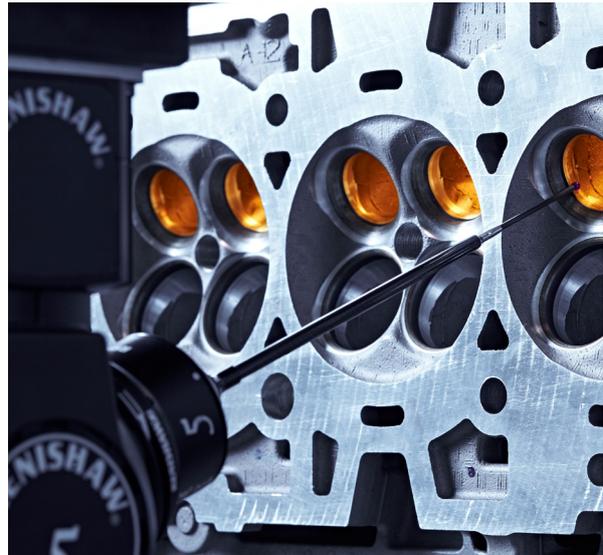
- The capital cost of the CMM and surface finish gauging equipment
- The labour requirement of the operations
- The time needed to carry out the measurements

5-axis CMM inspection, with integrated surface finish measurement, delivers a significant improvement in all three areas and results in a more efficient and agile system that saves money without compromising quality.

Improved methods

5-axis CMM measurement

Without the advantages of 5-axis control, all CMMs suffer from variable accuracy when scanning, getting worse at higher speeds. The acceleration and deceleration forces create noticeable amounts of bending in the machine structure and introduce errors in the measurement data.

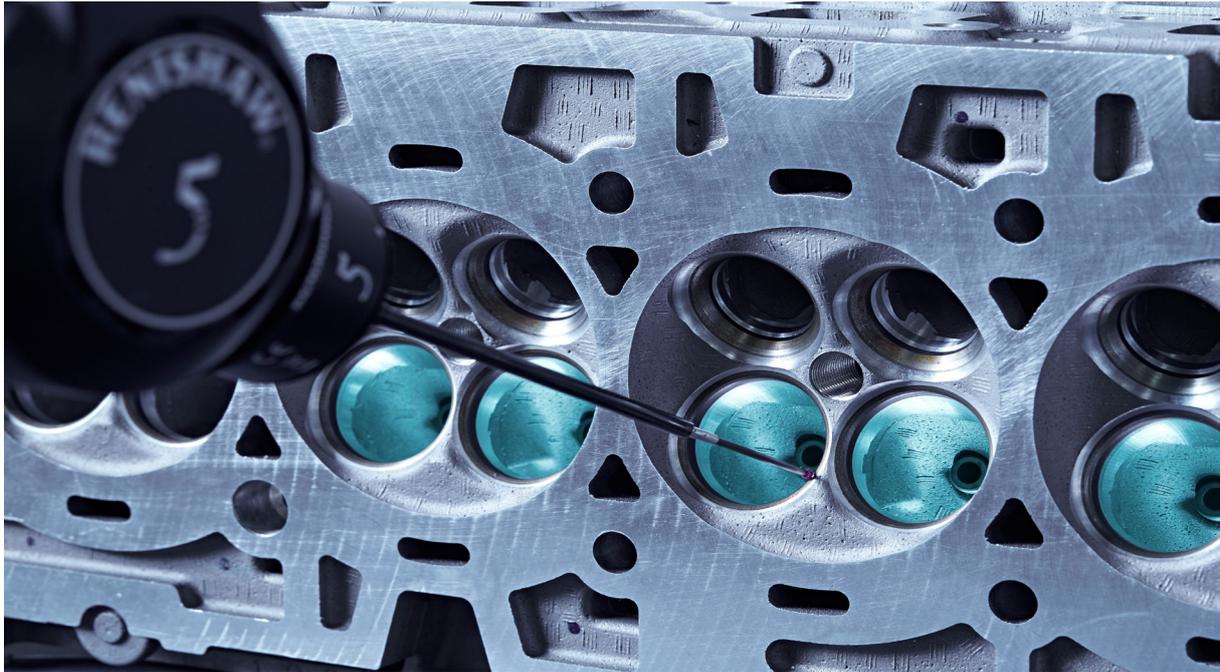


Automotive manufacturers benefit from up to a 50% reduction in cycle times when integrating surface finish measurement and dimensional inspection on a single 5-axis measuring CMM.

To prevent those errors and maintain accuracy, scanning speeds are kept deliberately low (less than 25 mm / sec). By adding a REVO-2 scanning head with two additional rotary axes, it is possible to remove those dynamic errors whilst still measuring at high speeds – up to 500 mm / sec. This is achieved by keeping the machine structure stationary and using the highly responsive REVO-2 head to carry out measurements such as circle scans. Where measurement paths need to synchronise more than two axes, such as when helical/spiral scanning, the X, Y and Z axes of the CMM can be programmed to move in a vector (a straight line, at constant speed), again allowing the REVO-2 head to carry out the high-speed scanning motion.

Integrating surface finish measurement and dimensional inspection

Conventional methods of inspection use two operations; firstly the CMM scans each feature and compares the results to the upper and lower tolerance limits and a pass or fail result is automatically reported to an SPC system. When all CMM measurements are completed, the part is transferred to a manipulator next to a gauging bench for surface finish measurements. The manipulator indexes the head into different orientations to access the surfaces to be inspected. Once in position, measurements are carried out manually with hand gauges. A typical set up uses 10 - 15 different gauges. Each gauge is placed by hand onto the component before the measurement cycle can be started.



REVO® 5-axis CMM systems with integrated surface finish measurement deliver a significant improvement in inspection time and labour requirements. for cylinder head quality control.

Integrating surface finish measurement and dimensional inspection on a single CMM eliminates this additional process and, when using 5-axis inspection technology, enables data capture at higher speeds so reducing cycle time – a 15% to 50% reduction is common. Similar savings are also made when inspecting cylinder blocks and gearbox casings.

REVO® system 5-axis measurement benefits at a glance

- Frees up floor space
- Fewer operations
- Quicker inspection results
- All data in a single digital report
- More flexibility
- Fewer styli

Tip sensing

The ability to use long-reach styli whilst also maintaining high accuracy is only possible by using 'tip sensing' technology. A laser is fired down a hollow carbon fibre stylus tube and reflected from a small mirror positioned directly behind the stylus tip. Because accuracy is similar at both short and long lengths, one stylus can be used for all measurements in most cases – saving calibration time and stylus inventory.



In 5-axis measurement the CMM moves at a constant velocity whilst the REVO-2 head performs all rotation and modulates probe deflection, simultaneously controlling the three machine axes and the two head axes.

Summary

A REVO® 5-axis multi-sensor inspection system provides increased speed and flexibility to inspect complex features such as valve seats and guides with accuracy and precision. The efficiency savings allow manufacturers to reduce capital outlay and annual labour costs.

For further information about REVO systems, visit www.renishaw.com/revo

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