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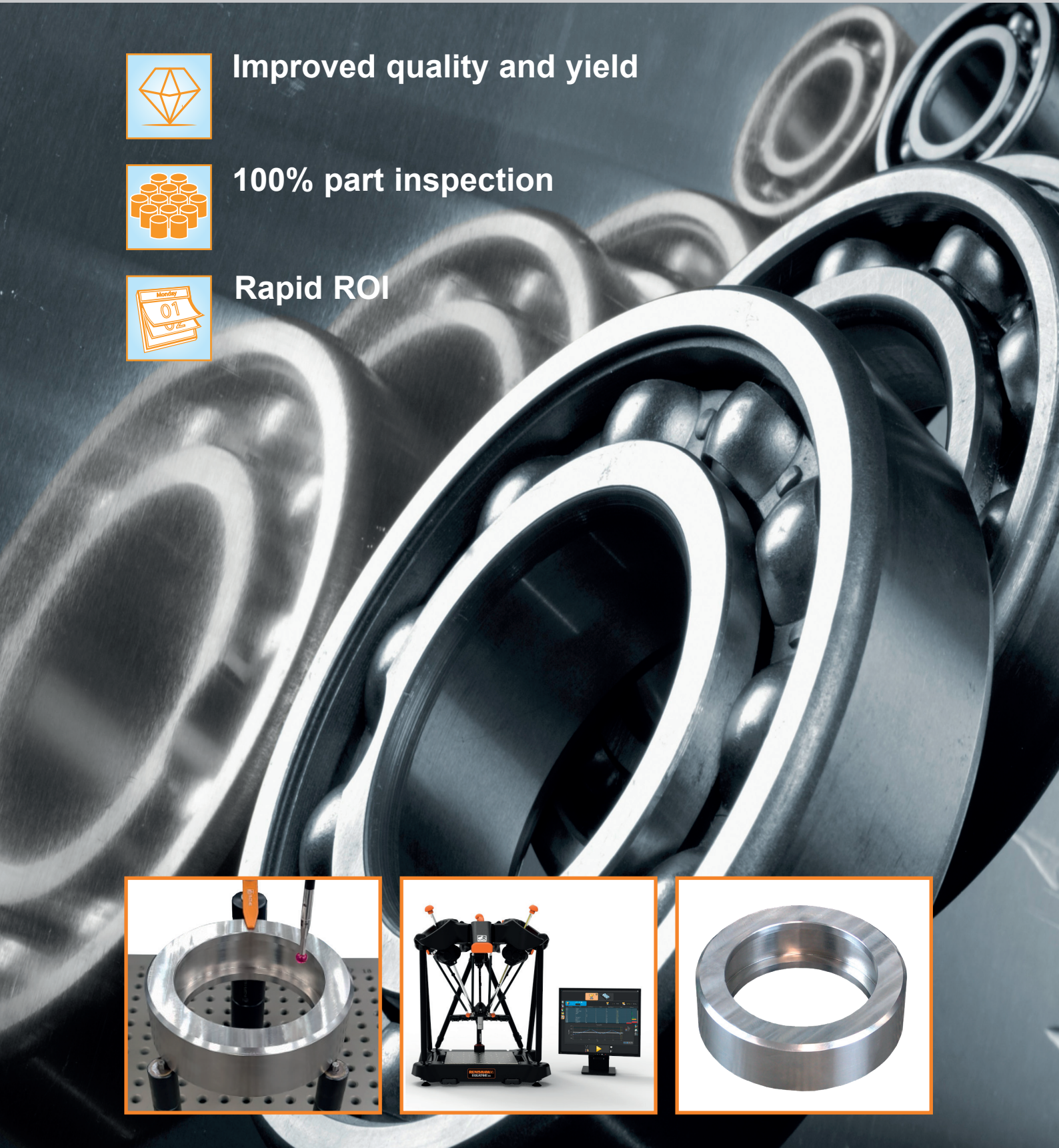
# Drive train bearing race: fast flexible gauging of size and geometry on high volume turned parts



- Improved quality and yield
- 100% part inspection
- Rapid ROI

# Overview

Manufacturers of bearing races use high speed CNC turning centres, with production involving several operations to create a bearing race for final bearing assembly.

Typically a combination of various forms of gauging are used alongside the machine to monitor bearing race quality and allow engineers to correct the process. However producers are now looking to reduce regular costly maintenance and high capital investment, and to improve production cycle times.

This case brief examines a typical bearing race process with actual benefits that have been experienced by manufacturers using the Renishaw Equator™ gauging system.

## Example bearing manufacturing process* - *without the Equator™ gauge*


Bearing race machining and treatment

*Other manufacturers' processes may differ.

## Challenges

### 1 Combine all the gauging and inspection activities into a single operation

One device gauges size, position and geometric features, keeping pace with machining time.

### 2 Improve process yield and quality

Reduce variation by gauging critical features and keeping part dimensions as close to nominal as possible.

### 3 Reduce operating costs

Eliminate manual gauging tasks, with associated costs and reduced demands on the quality room.

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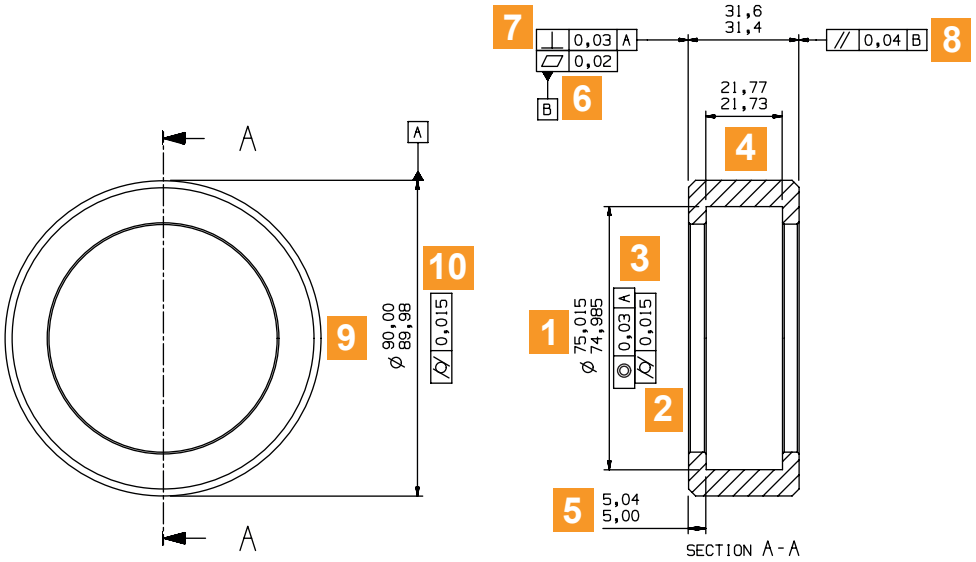
# Inspection requirements for a bearing race




| # | Inspection | Tolerance | Why is this feature critical to part function? | Active tool offsetting action |
|---|---|---|---|---|
| 1 | Track diameter | ±15 µm (±0.0006”) | Poor clearance with the outer race will result in reduced efficiency and reduce life of the bearing. |  |
| 2 | Track cylindricity | 15 µm (0.0006”) | Poor cylindricity increases wear, sticking of rollers and burnout. | |
| 3 | Track concentricity | 30 µm (0.0012”) | Poor alignment of track, rollers and inner race increases wear, sticking of rollers and burnout. | |
| 4 | Track width | ±20 µm (±0.0009”) | Controls the amount of axial movement of the rollers and ensures they run smoothly. |  |
| 5 | Shoulder width | +40 µm (+0.0019”) | This ensures shoulder widths are sufficient to withstand axial force. |  |
| 6 | Face flatness | 50 µm (0.0016”) | This ensures bearing runs correctly. Misalignment results in axial stresses to shaft. | |
| 7 | Perpendicularity | 30 µm (0.0012”) | This ensures bearing runs correctly when assembled. Misalignment results in axial stresses to shaft. | |
| 8 | Face parallelism | 40 µm (0.0019”) | Ensure bearing runs true when assembled and does not apply axial stresses to shaft. | |
| 9 | Outer diameter | -20 µm (-0.0009”) | This ensures the bearing fits correctly when assembled and is not distorted. |  |
| 10 | Outer diameter cylindricity | 15 µm (0.0006”) | This ensures the bearing fits correctly when assembled and is not distorted. | |

**Key:**

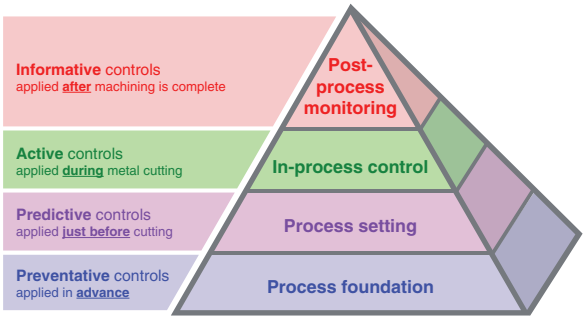
Automatic update of machine offsets through inspection of indicated features.

**Please note: In addition to the feedback of geometric features, the monitoring of form can be indicative of the health of the tools.**

# Process considerations

Renishaw engineers considered key elements within the bearing race manufacturing process using Renishaw's ***Productive Process Pyramid***™. This framework is used to identify and control the variations that can occur at key stages of the machining process.

For this process, methods to control variation include machine maintenance and calibration, tool breakage detection and shop-floor gauging for inspection and feedback.

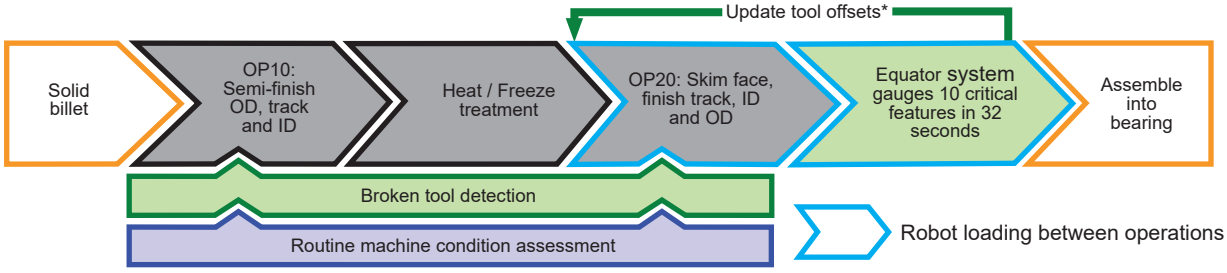



**Productive Process Pyramid**

## Manufacturing process - opportunities for improvement

### Original process


### Improved process




* Offset updates can be automatically applied using IPC (intelligent process control) software which uses dimensional data to feedback offset updates to CNC controllers. Updates could alternatively be applied manually based on the inspection data displayed in Process Monitor.

# Typical results

Bearing race manufacturers have installed Equator gauging systems to consolidate all measurements onto one device, which significantly reduces operator costs. Equator gauges compare production parts against master part inspection data. Remastering removes thermal effects and ensures high repeatability over a wide temperature range. Inspection results are captured in a way that enables easy reporting, analysis and feedback to improve process control.

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# Typical results

## 1 Combined single operation

With the Equator™ gauge, all gauging is done on one gauge, within the target time, including the position and geometric form features. Previously manual gauging had been used to gather single point data and multiple stations were needed.

High speed scanning on the Equator gauge, plus the ability to gauge every feature in 'one-hit' means every part is fully gauged.

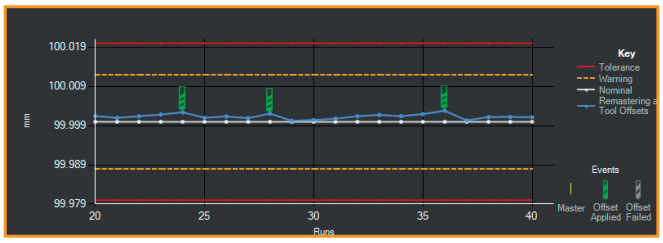
All ten features are controlled with a gauging cycle time of 1 minute 35 seconds.

| # | Inspection<br>Total time: 1 min 35 secs | Tolerance | Gauge R&R % of tol* | Gauge R&R range* |
|---|---|---|---|---|
| 1 | Track diameter | ±15 µm (±0.0006") | 8.9% | 2.2 µm (86.6 µin) |
| 2 | Track cylindricity | 15 µm (0.0006") | 8.1% | 1.6 µm (63 µin) |
| 3 | Track concentricity | 30 µm (0.0012") | 4.2% | 1.6 µm (63 µin) |
| 4 | Track width | ±20 µm (±0.0009") | 9.4% | 2.1 µm (82.7 µin) |
| 5 | Shoulder width | +40 µm (+ 0.0019") | 9.5% | 2.4 µm (94.5 µin) |
| 6 | Face flatness | 50 µm (0.0016") | 5.5% | 1.6 µm (63 µin) |
| 7 | Perpendicularity | 30 µm (0.0012") | 5.4% | 2.1 µm (82.7 µin) |
| 8 | Face parallelism | 40 µm (0.0019") | 1.8% | 1.0 µm (39.4 µin) |
| 9 | Outer diameter | -20 µm (-0.0009") | 5.2% | 0.6 µm (23.6 µin) |
| 10 | Outer diameter cylindricity | 15 µm (0.0006") | 9.9% | 2.0 µm (78.7 µin) |

* Type 1 Gauge Repeatability and Reproducibility - loading and unloading the same part 30 times.

## 2 Improved process yield and quality

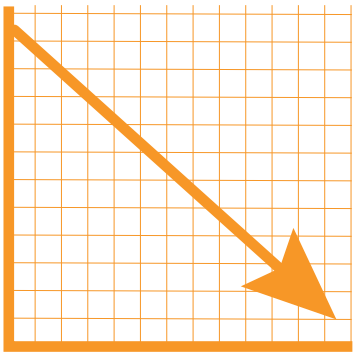
Equator gauging systems provide fully automated offset compensation using IPC software. Equator gauging data on critical features is constantly monitored. When any tool offset updates are required they are sent to the CNC control, adjusting the machining of subsequent features to bring the parts back towards the nominal value.




Example of Process Monitor screen showing drift due to tool wear, corrected by IPC

## 3 Operating costs reduced

Equator gauges are doing all the gauging required, on one device, saving the cost of multiple manual gauges. With IPC implemented, tool wear is being accurately monitored, reducing tool costs as the full life is achieved from each tool. Costs have also been cut by removing the need to take sample parts to the quality room to measure critical geometric features on a CMM. Part selection takes seconds using an Equator gauge and has reduced the change over time compared to manual gauges.



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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:**

- Additive manufacturing and vacuum casting technologies for design, prototyping, and production applications
- Dental CAD/CAM scanning systems and supply of dental structures
- Encoder systems for high-accuracy linear, angle and rotary position feedback
- Fixturing for CMMs (co-ordinate measuring machines) and gauging systems
- Gauging systems for comparative measurement of machined parts
- High-speed laser measurement and surveying systems for use in extreme environments
- 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
- Styli for CMM and machine tool probe applications

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