High resolution and very precise

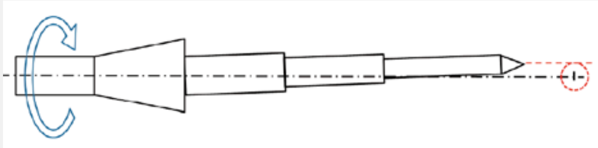
Camera System Measures Concentricity of Shafts and Grinders

Part of the shaft runout test facility (Compar)

The Sirona company in Bensheim (Germany) manufactures grinding machines with which dental fillings are produced automatically from CAD data. The demands on the accuracy of the fillings are high, and the equipment must also work with corresponding precision. Although the grinders used in the production are consumables, they must be very precise and their concentricity must be in the micrometre range. With the help of industrial image processing, the products can be 100% inspected in the manufacturing process with high precision.

Definition of the Concentricity

Concentricity is the maximum distance of the curve that the tip of the shaft or slider describes in relation to the centre of this axis during a rotation of 360°. The direction of the axis of rotation is determined by the axis of the shaft.



In Fig. 1, a grinder is shown schematically and the concentricity according to DIN EN ISO 1101 is sketched with a red circle. (Compar)

Compar AG | Rietbrunnen 44 | CH-8808 Pfäffikon SZ | info@compar.ch Phone +41 55 416 10 60

Measurement of Concentricity

For the measurement of concentricity, the grinder is clamped in a collet and rotated. The image processing system takes 64 images during one rotation of the grinder and determines the axis of rotation and position of the tip in each image.

A 2456 pixel x 2058 pixel camera, telecentric optics and collimated illumination are used to capture the image.

Fig. 2 shows an image in the upper section and below it the measurement of the axis of rotation, the position of the tip and the measurements for the concentricity of the axis and tip. The upper section also shows the result of the runout measurement according to DIN EN ISO 1101, in this case with a radius of 11.4 micrometres.

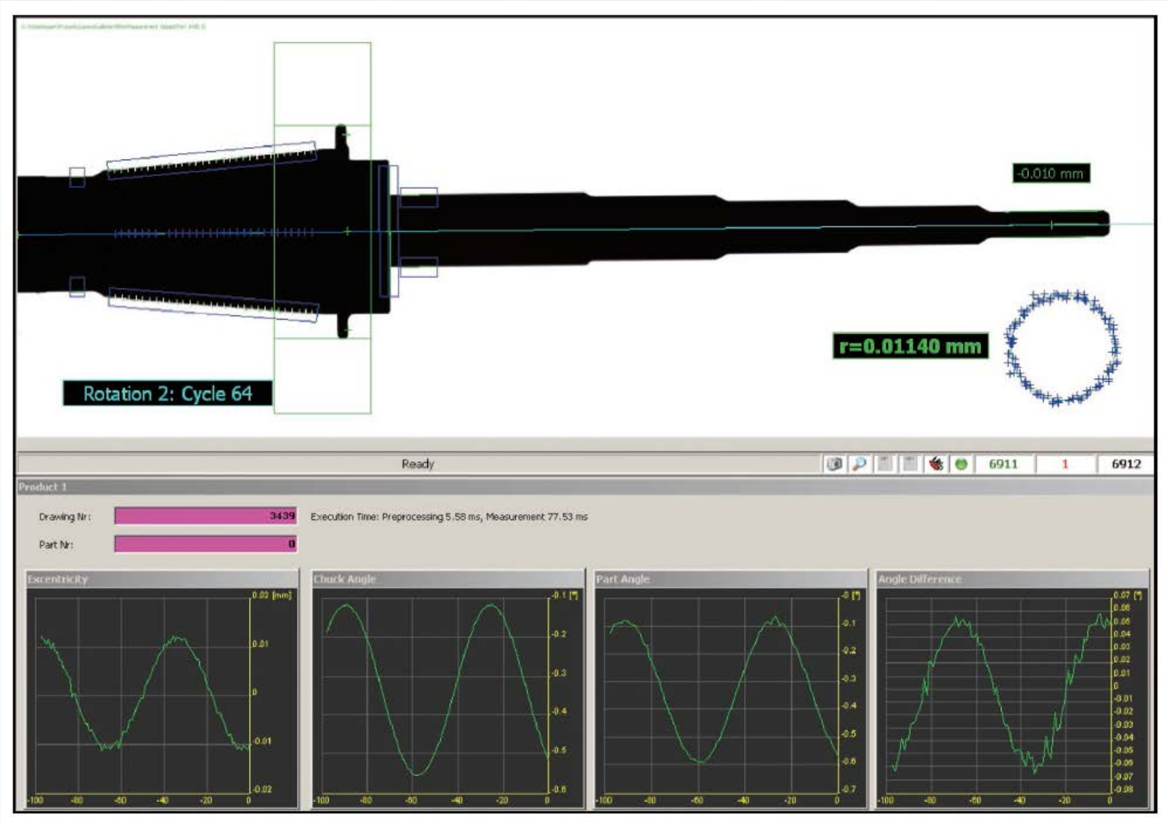


Fig.2: Upper area: image acquisition; the measured radius and the graphical representation of the runout are shown.
Lower area: Measurement course of the rotation axis, position of the tip, as well as measurements for the concentricity of the axis and tip. (Graphic: Compar)

Compar AG | Rietbrunnen 44 | CH-8808 Pfäffikon SZ | info@compar.ch Phone +41 55 416 10 60

Project Procedure

In a first phase, preliminary tests were carried out to check the measurement concept. Thanks to the PC-based VISION***expert***® image processing platform, rapid prototyping was possible. This platform is a PC-based system with highly developed algorithms for dimensional metrology.

The measurements were checked on sample parts and statistically evaluated. The comparison of the measurements of the image processing system with those of a coordinate measuring system showed a very high agreement of the values (Fig.3). Since all images taken with the image processing system were automatically saved during the tests, individual outliers such as part 2 in Fig. 3 could be analysed more closely. It turned out that the deviations were due to dirt particles, which in turn gave a useful indication of the cleanliness requirements for the realisation.

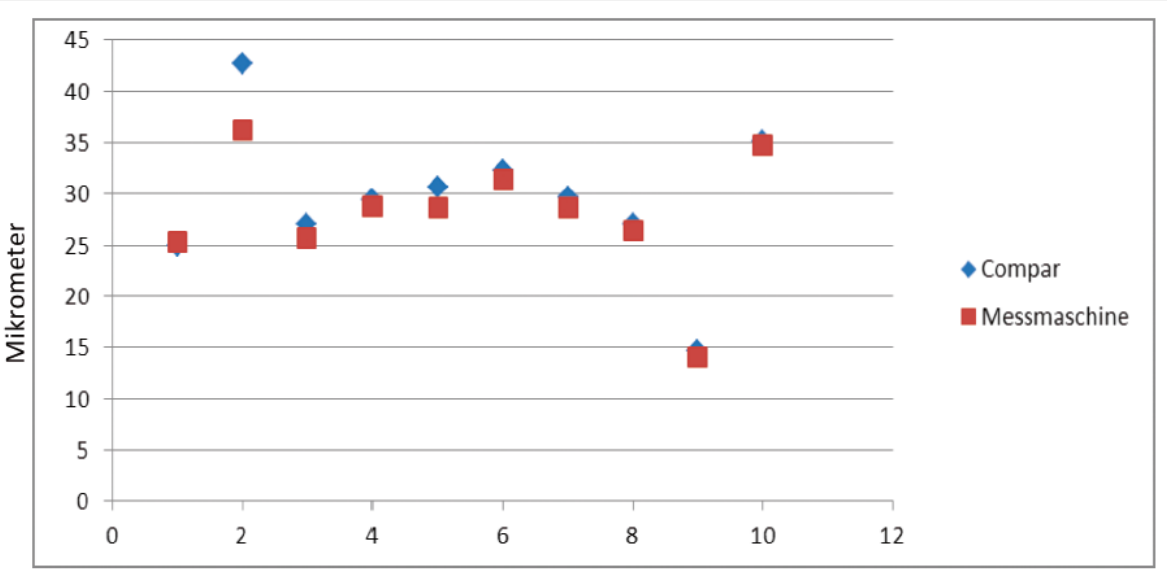


Fig.3: Comparison of the measured values in micrometres from the coordinate measuring machine and the vision system, recorded for 10 parts. The outlier (part 2) is due to dirt particles.
The measurement results achieved across all different product types are very precise and stable with an overall repeatability <1µm and an overall reproducibility <1.5µm. (Graphic: Compar)

Realisation

The realisation took place on the same platform on which the "fast prototyping" was done. It went quickly because VISION***expert***® was also the target system.

For the automation, an automatic loading of the test station was built, which was realised by a specialised plant manufacturer using an EPSON robot. Fig. 4 shows part of the measuring system.

Fig.4 Part of the test equipment (Compar)

Compar AG | Rietbrunnen 44 | CH-8808 Pfäffikon SZ | info@compar.ch Phone +41 55 416 10 60

Conclusion

The advantages of the presented solution are convincing:

- The measuring accuracy of the image processing system is comparable to the one from the coordinate measuring system used previously.
- Thanks to automation, the total cycle time could be reduced from approx. 3 minutes per part to 18 seconds. Thanks to the short cycle time, a 100% inline inspection can now also be carried out on larger quantities.
- Massive savings were achieved in the costs of the inspection system, as the image processing solution is more than a factor of 6 cheaper than a measuring machine based on a coordinate measuring system.
- Bad parts are detected at an early stage and rejected before further processing, which in turn saves costs.
- The measured data can be automatically logged together with the test conditions. Proof of quality and traceability are thus ensured.

Thanks to automation, productivity can now keep pace with the increasing production volume, enabling Sirona Dental Systems to consolidate its position as the world's leading manufacturer of systems and equipment for the dental sector.

Contact:

Compar AG, Rietbrunnen 44, CH-8808 Pfäffikon SZ, Switzerland

Phone: +41 55 416 10 60, info@compar.ch, www.compar.ch