

Steering right

BERND BALLE *

Bernd Balle (bernd.balle@zeiss.com), Carl Zeiss Industrielle Messtechnik GmbH, Oberkochen, Germany

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Abstract

Reliable measuring results around the clock – this is how TRW Automotive ensures the quality of its steering components down to the sub-micrometer range. The coordinate and surface measuring machines in steering system production at the automotive supplier's Poland facility must be accordingly accurate and reliable. If the values for a workpiece exceed tolerances, the entire production line has to stop immediately. This can quickly result in high costs.

KEYWORDS: the steering components, speed and precision, coordinate and surface measuring machines

“People’s lives depend on our products. For this reason, quality is our top priority. This is the focus of our production activities – and also the reason why we need the best measuring technologies and tools,” says Jarosław Muchajer. As a quality manager at TRW Automotive, he is responsible at one of the company’s Polish sites in Bielsko-Biała for the most complex and expensive component of a vehicle after the engine: the steering system.



Fig. 1. Jarosław Muchajer is a Quality Manager at TRW Automotive for steering systems in Bielsko-Biała, Poland

For larger vehicles and luxury models, electronic power steering with a belt transmission is often used. One of its key parts is positioned horizontally between the front wheels, which moves left or right depending on the steering direction. The driver is supported by an electric motor that drives the belts wrapped around the ball nut. This spindle is connected to the rack via a thread. TRW needs nine processing steps to create the rod from raw steel: it is given teeth and a thread, hardened and straightened under pressure. In the end, it is screwed together with the ball nut which is also manufactured in a complex process.



Fig. 2. Quality has top priority in the production of all steering wheel components at TRW Automotive



Fig. 3. One of the key parts of an electronic power steering system with a belt transmission is the rack, positioned horizontally between the front wheels

The marriage of production and the measuring technology

Errors in the production of the rack can not only lead to unpleasant noises while steering, but would also increase the risk of an accident if the steering is too easy or difficult to move, locks or suffers excessive wear and tear as a result of strong friction. Therefore, Muchajer and his colleagues closely monitor the production of the racks. In addition to regular tests for hardness and fatigue, the geometry, form, surface contour and roughness of the parts are continuously monitored. The rack is allowed to deviate from its ideal roundness by no more than five micrometers, 10 micrometers in diameter and only 0.1 micrometer in surface roughness. In addition to the characteristics that must be captured to meet the minimum requirements of car makers, the quality managers have added further parameters to their measuring

plan for safety. A total of 110 characteristics must be measured on each workpiece that is pulled for random sampling. The steel bars roll off the production line in Bielsko-Biała every 40 seconds. Random samples are taken in the measuring lab two or three times per shift for each processing step.

If one parameter exceeds tolerance, the entire production line comes to a stop until corrections are made and additional measurements confirm that everything is within tolerance. Every minute of downtime costs the company money. The value of quality inspection is therefore accordingly high: "Our measuring process is part of the production process," explains Tomasz Wadon who is in charge of the measuring lab in Bielsko-Biała. "If anything is not working properly, we have to stop production. Therefore, the reliability of the measuring machines is vital."



Fig. 4. Measuring lab supervisor Tomasz Wadon and Lab Supervisor for Testing & Product Reliability, Maciej Kawiak, discuss the measurement of a rack

Setting the standard

When the Bielsko-Biała factory opened in 2012, plant managers drew on their own experience at the TRW facility in Czechowice-Dziedzice 7 kilometers away when it came time to select the coordinate and surface measuring machines. The company introduced a ZEISS PRISMO there in 2001. A second was added six years later. Maciej Kawiak, former Lab Supervisor - Metrology&Test in Czechowice plant, remembers: "Word of the high precision and reliability of this machine quickly spread throughout the company. The measurements from Czechowice-Dziedzice were soon used as a reference for other TRW sites around the world: "Whenever anyone doubted their measurement results, they sent the workpieces to us to be measured."

Today, the ZEISS PRISMO ultra bridge-type measuring machine is part of the standard equipment at TRW Automotive. Two new units were installed at the Bielsko-Biała plant in 2013 and 2014. The two high-precision measuring machines are supplemented by a ZEISS ACCURA II bridge-type measuring machine and the much smaller ZEISS DURAMAX coordinate measuring machine. They are used for random sampling, incoming goods inspection and measurements of prototype parts. The PRISMO ultra is primarily used for regular random sample measurements of steering wheel components for which particularly narrow tolerances must be complied

with – like the rack. The checks include diameter, roundness and form, and coaxiality for the rack, i.e. compliance of the rotational axis. The main advantage of the ZEISS PRISMO, DURAMAX and ACCURA II: the contact sensor scans and quickly captures the entire geometry of the part unlike single-point measurements. The rotary table, which TRW uses on almost all the coordinate measuring machines at its Polish sites, has proven its value to the company. It rotates the workpiece in the right direction to the stylus without requiring operator intervention: “The geometry of the rack is highly complex and must be measured from multiple angles,” explains Measuring Lab Manager Wadon. “The rotary table is therefore a great solution.”

Less than 0.1 micrometers

In addition to the coordinate measuring machines, TRW also uses three ZEISS SURFCOM 1500 and SURFCOM 5000 contour and surface measuring instruments in Bielsko-Biała. Without these measuring machines, the production of certain workpieces would not be possible according to Wadon. The contour and roughness of the surface are factors relevant to functionality, particularly for components such as the rack. Since the introduction of the SURFCOM 5000 a few months ago, the company has been able to measure roughness of less than 0.1 micrometer. Wadon and his colleagues are fascinated by this development: “If you had told me a few months ago that we would ever measure values below 0.1 micrometers, I would have thought you were crazy.” Most random sample measurements on the surface and coordinate measuring machines are not done by measuring technicians, but by the operators.



Fig. 5. Racks are allowed to deviate from their ideal roundness by no more than five micrometers, 10 micrometers in diameter and only 0.1 micrometer in surface roughness

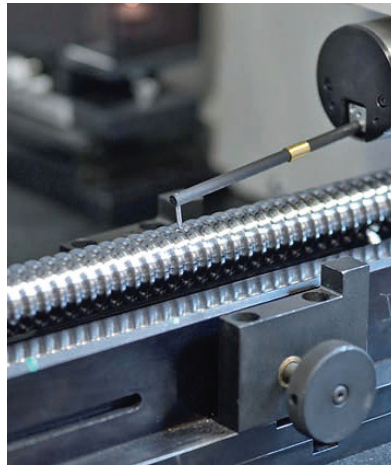


Fig. 6. The SURFCOM 5000 contour and surface measuring instrument delivers roughness values of less than 0.1 micrometers



Fig. 7. Worm shaft as a component of the gearbox. Worm gears are used when the gear speed reductions are needed

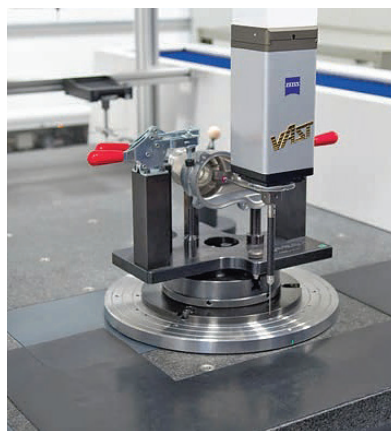


Fig. 8. A rotary table turns the workpiece in the right direction to the stylus without the operator having to intervene

Using special fixtures, they clamp the workpieces on the measuring machines brought to the measuring lab by production staff. They then start the respective measuring program prepared by the measuring technicians. The measurement of a 110-characteristic rack on a coordinate measuring machine takes 30 minutes. The contour and surface measuring instrument needs another five minutes to check all specified characteristics.

Software and service

As important as precision and speed were for the selection of the measuring machines, software and service were also key criteria for the quality managers and measuring technicians. TRW uses CALYPSO measuring software on all of its coordinate measuring machines. This software enables the measuring technicians to work directly with the CAD data. Highly specialized software options such as the measurement of ball screws or gearing are also very important. Service is also a success factor for TRW: like its production activities, the company runs its measuring lab 24 hours a day. If any problems occur, the measuring technicians must be able to contact service staff familiar with the measuring machines around the clock.



Fig. 9. "Word of the high precision and reliability of this system quickly spread throughout the company," says Maciej Kawiak, Lab Supervisor – Testing & Product Reliability

A plus for Measuring Lab Manager Wadon regarding the ZEISS machines was that ZEISS specialists are available at any time just 50 kilometers from the Bielsko-Biała site. If needed, they can be quickly on site, e.g. if a measuring machine malfunctions. However, TRW has the systems serviced twice a year to detect any possible problems before they occur. This will become even more important in a few months when a second production line goes online. It will increase the number of racks for power steering to one million annually. This also means that new equipment will be added to the measuring lab: a third ZEISS PRISMO ultra coordinate measuring machine has already been ordered.

References

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