Defect detection while hot

Increased rail track performance at reduced life cycle costs can only be achieved with outstanding quality control throughout the entire production process. Austria's voestalpine Schienen not only sets high standards on the global stage with its high-quality products, but also excels in complex measurement and inspection tasks. NEXTSENSE's high-precision surface inspection and flatness measurement systems have become an indispensable part of the steelmaker's rolling mill in Leoben where its latest innovation enables the detection of defects on surfaces while they are still hot.

BASED in Leoben-Donawitz in Austria, voestalpine Schienen is the European market leader in the production of long rails. It's new and innovative rolling mill sets the global industry benchmark and produces long rails of up to 120m. 24/7 production shifts mean an annual volume of 600,000 rails. The high standards demanded of the rails call for 100% surface error detection and dimensional accuracy testing. Due to increased demand for high-speed tracks, production is particularly affected by the tremendous increase in quality standards. With this in mind, a constant and professional supervision along with technological advances made to inspection systems are of utmost importance. At voestalpine Schienen's testing facility in Leoben, Andreas Gerold takes care of these continual improvements.

NEXTSENSE is an important player in the world of inspection technology. The Austrian company established itself as an innovation leader and an important long-term partner of voestalpine at the steelmaker's rolling mill in Donawitz.

"Our co-operation with NEXTSENSE dates back to the year 2001. At that time, the corporation was still a research project of Joanneum Research. Yet, since then four more systems were developed – and the fifth is currently ordered", says Gerold.

NEXTSENSE develops, produces and sells stationary surface inspection and profile measurement systems, known as SURFILES.

Andreas Gerold next to the surface inspection system in the testing centre

Detection of surface defects

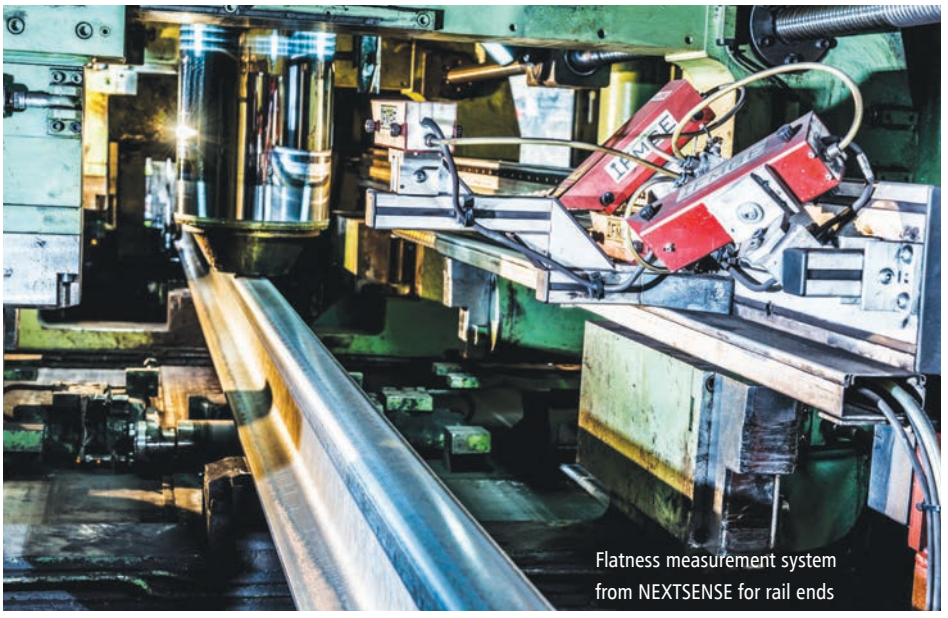
In 2001 the worldwide unique offer of ultra-long 120-metre rails set new challenges for inspection and measurement systems because simple visual inspection by the human eye no longer met efficiency or precision requirements.

"Due to a fact that rails of this length cannot be easily rotated, it was no longer possible to identify all defects with the naked eye simply by walking around the rails and assessing the faults", says Gerold. At voestalpine Schienen the need for automatic systems capable of detecting surface defects on long rails became paramount. So voestalpine got in touch with the founders of NEXTSENSE, who at that time worked as researchers for Joanneum Research at the Institute of Digital Image Processing.

"At that time there was no such system on the market, so we turned to a research association," said Gerold. Co-operation between voestalpine and the founders of NEXTSENSE led to the development of the world´s first optical surface inspection system for cold-rolled material. It was installed and implemented at voestalpine Schienen and so started a long-lasting and successful partnership.

Gradual integration

NEXTSENSE´s first surface inspection system was based on the "Shape from Shading" measurement method where 3D surface structure is calculated on the basis of light distribution in images. Fifteen years ago, this method was seen as a huge quantum leap in measurement technology. For the first time ever, it was possible to detect surface defects on rolled material fully automatically. The system has been in operation for more than 15 years and has been regularly updated to meet the individual needs of voestalpine. For example, a new LED lightening system



Flatness measurement system from NEXTSENSE for rail ends

containing more than 1,100 blue and red radiant LEDs (Light Emitting Diodes) was implemented to make even the smallest defects on the surface of rails visible. Extensive system integration in the rolling mill is another case in point – the results are no longer used only in the testing centre, but are also integrated in the subsequent process of straightening in the final inspection station. Furthermore, the straightening process control system has been coupled with the error positions. "We cannot imagine our production without it. The inspection system is so well integrated into our production process and the material flow system that it would be impossible to replace it", says Gerold.

Expansion to hot surfaces

In the spring of 2016 voestalpine acquired its second surface inspection system from NEXTSENSE, but this time to detect defects while the rail was still in the hot state – directly after the rolling process. "The clear advantage of this system is that surface quality can be ensured already in the early phase of production, which makes it easier to prevent defective production and reduce rejects", says Gerold about the new DIRIS 3D HOT system. It is now no longer necessary to wait until the rolled workpiece cools down to detect defects like scabs, reefs, roll-ons, or scales to intervene and take appropriate measures. "The great advantage is that error-handling procedures can be carried out promptly after the production, which results in increased output", explains Gerold.

The previously prevailing visual inspection process with bare eye turned out to be very complex and difficult. The optical measurement technique of the new system, however, enables 100% coverage and simple control. "The system represents a tremendous support for inspectors as they can examine every defect in high-resolution on their screens", says Gerold.

Contactless technology

The main difference between the DIRIS 3D HOT system and the cold surface inspection system lies in the applied laser light section technology. The former enables glowing surfaces to be examined with extreme accuracy. Several laser lines are projected onto the rolled material and multiple high-end cameras capture the surface profile in 3D. In addition to defect size detection, the system can determine the depth of the defect. Sensors are arranged annularly around the measured rail passing through the centre of the system. The rail structure is subsequently scanned with the resolution of less than 1/10mm and is digitally processed. Huge amounts of data, which can reach to several gigabytes of image data per rail, can be evaluated within seconds in a computing cluster. Rolling defects can be detected quickly and reliably. Automatic defect recognition allows for the classification of defects and the categorisation of surface structures. All the information is stored as a SQL database on a server, from which complete quality and defect lists can be later directly exported.

In order to detect difficult to reach areas, such as the transition between the web and head of standard rails, or between web and grooves of grooved rails, the construction of the measurement system is designed so that it can be tilted. Moreover, the DIRIS 3D HOT system is not rigidly pre-programmed, but can be adapted to individual defect specifications during the system's lifespan. "The system was adapted to our specific production requirements and plays a pioneering role in the industry. Nothing comparable exists in the entire market", says Gerold.

Process integrated inspection systems

Other NEXTSENSE systems can be found in the next production step of the rail production process – the straightening process. Two high-precision flatness measurement systems (FMGs) are used to optimise rail flatness and simultaneously present the unique possibility to determine the flatness of the ends of the rail.

"The problem with conventional systems is that they cannot measure the last five metres and thus the ends cannot be assessed. You should either cut this part or measure it manually with rulers. This, of course, is very time-consuming and demanding work, which is now carried out by FMGs", explains Gerold.

NEXTSENSE´s laser light section technique and its complex mathematical algorithms mean that manual inspections are a thing of the past. In addition to horizontal flatness, the vertical flatness of rail ends can also be determined. Flatness graphs with digital classification rulers and detailed valley depth displays are used for data evaluation and visualisation. A colour code according to set testing standards displays the results neatly arranged. "The crucial point as to why we opted for NEXTSENSE as a partner for flatness measurement systems as well, is on the one hand a favourable price-performance ratio and on the other the great experience we gained with the company through our pre-projects", explains Gerold.

Prosperous future

Voestalpine Schienen strives to further develop and improve its products. For this reason, the company strives hard to continue to be the global benchmark and the innovation leader in measurement and inspection tasks – entirely in line with the motto 'one step ahead'. Nevertheless, voestalpine Schienen is not the only Austrian company with plenty in store for the future. NEXTSENSE has great plans too and its innovations are set to attract attention going forward. ■