

Reset your geometry

Konecranes uses a self-tracking interferometer to inspect and calibrate its machine tools – bringing them back to their original specifications

Konecranes Machine Tool Service (MTS), headquartered in Finland, is one of the world's largest providers of machine tool servicing. With hundreds of service specialists based in many locations including China, Estonia, Finland, Norway, Sweden, the UK and USA, the company is able to offer a full range of preventive maintenance, rebuild, remanufacture, retrofit and repair services as well as onsite support for all types and brands of machine tools.

"We encourage our customers to do proactive maintenance in order to enhance productivity and minimize downtime," explains Jukka Penttinen, Manager at MTS Finland. "For succeeding in a highly competitive environment, it is imperative for all businesses to have machine tools that are operating within optimum geometrical and positioning specifications. Noncompliance can lead to severe production inaccuracies and out-of-tolerance parts."

Originally, Konecrane's Finnish branch had outsourced the measurement service, but with increased requirements for machine accuracy, and as the highly-precise measurement of machine tool geometry has become an integral part of machine maintenance, Konecranes decided to bring 3D metrology in-house.

"Our subcontractor used a traditional laser interferometer for linear positioning measurements. At first glance, this seemed to be the perfect solution. However, when screening the market for an adequate laser interferometer, we came across Etalon's LaserTRACER, an advanced, self-tracking laser interferometer with sub-micron accuracy," reports Juhana Moisio, MTS Support Manager at Konecranes.

"With the help of the LaserTRACER, we are able to return any machine to original specifications very quickly. Konecranes is also the first machine tool service provider who can do volumetric measurements and compensations including a direct transfer of correction data into the control software of the machine tool. This is a great advantage for our customers."

Nanometer resolution

Etalon's LaserTRACER was developed for calibration, monitoring and accuracy enhancement of measuring machines and



machine tools. It automatically tracks a reflector, and so allows for the high precision identification of geometrical deviations. A key feature is that it gives extremely high accuracy of the centre of rotation thanks to a patented measurement technique: a sphere with a form deviation of just 50 nanometers is used as an optical reference for the interferometer. As a consequence, the mechanical errors of the rotation and swivel axes are fully compensated.

Fast error tracking

The system fundamentally simplifies geometrical error tracking on machine tools. With conventional measuring equipment such as ballbars or traditional laser interferometers, the determination of all geometrical deviations of machine tools requires extraordinary efforts – in case of a 5-axis machine, the entire process can take several days. But, says Juhana Moisio: "Geometry verification with the LaserTRACER is normally performed during one day, depending on the complexity of the particular machine tool."

Combined with sophisticated software, the measuring system analyses the entire working space of the machine tool. It delivers a measuring uncertainty for spatial displacement (95%) of $0.2 \mu\text{m} + 0.3 \mu\text{m}/\text{m}$ and determines position deviations, straightness deviations, rotational deviations (pitch, yaw, roll), and the squareness of axes to one another. Angular positioning deviations, axial and radial movements, and wobbling of the rotational axes are recorded too.

Easy data transfer

To carry out the measurements, the LaserTRACER is placed stationary at several different positions inside the working volume of the machine. The application system specialist mounts the reflector to the tool. In the following automated measuring process, the LaserTRACER tracks the actual path of the machine in its entire working volume.

What are geometric errors?

These are error motions between the machine and the workpiece. Each movement of a machine axis can be described by six degrees of freedom: three translations and three rotations. The notation of an axis movement is standardized in ISO 841: X, Y, and Z denote the linear movements, A, B, and C the rotations around X, Y, and Z respectively.

For a nominal linear movement, the six component errors are the position error, two straightness error motions, roll error motion and two tilt error motions, which are called pitch and yaw error motion for horizontal axes.

Under the assumption of rigid body behavior, these errors are functions of the nominal movement only and do not depend on the location of the other axes.

For a nominal rotational movement, the six component errors are two radial error motions, one axial error motion, the angular position error, and two tilt error motions.



The required NC programs are automatically generated by Etalon's software, and the respective distances to the tool centre point determined via interferometer. The Etalon system transfers the recorded measured data to the connected Trac-Cal measuring software, which automatically processes the measured data. The compensation data obtained such can be visualised and then directly imported into the control software of the machine tool.

"Compensation is easily done with modern Fanuc, Siemens and Heidenhain controls," says Sami Lehvonen, the system specialist of LaserTRACER at Konecranes. "Yet, as far as our experience goes, also other brands are possible in most cases."

Manual data processing by the application system specialist is not necessary as Etalon has been closely cooperating with controller manufacturers to ensure problem-free transfer of the correction data to the controller software.

Etalon has done a great job on training our staff...

"We have two technicians trained on the LaserTRACER," clarifies Juhana Moisio. "They are skilled in machine tool service providing and geometric measuring. We believe that the user of the LaserTRACER system should have a good technical background to operate the system smoothly. You need specific knowledge and experience to use the system efficiently. Etalon has done a great job on training our staff in a target-oriented and sustainable way."

Konecranes has split the 3D measurement services with the LaserTRACER into four modules, allowing for tailor-made measurement execution according to the customer's needs: From 'simple' geometry verification with axial or diagonal measurement according to ISO 230-2 and ISO 230-6 to extensive geometry calibration, from fast rotary axis calibration to circularity verification according to ISO 230-4 – every need can be fulfilled without generating overhead measurements.

'The one and only'

After having applied Etalon's system for

24 months, Konecrane's Support Manager Juhana Moisio says: "When you measure a machine for the very first time with the LaserTRACER, it takes you a bit longer because you need to plan and check a lot of things before conducting the measurement. But the second time, it is much faster because all basic information is already available. Therefore, we intend to make long-term contracts with our customers for periodic machine checks and re-calibration. We depict the advantages of such systematic action of preventive maintenance, including minimum downtime and maximum compliance with workpiece geometries. Most customers are aware of the potential and make use of this convenient productivity boost."



"To sum things up: When environmental conditions are alright, when the machine tool is suitable for the measurement, and when you are familiar with the system, it's very precise, very fast, reliable and a quite easy tool for demanding and versatile measurements. I would even say: It's the one and only for volumetric measurements at the moment."

The next generation: LaserTRACER-NG

Whereas Etalon's LaserTRACER relies on good environmental conditions with respect to cleanliness, stability, temperature etc., the follow-up model LaserTRACER-NG, which premiered at the AMB show 2014, is an entirely redesigned system that consolidates Etalon's experiences gained during the last ten years of machine calibration. Shop floor suitability was a major aspect when redesigning the measurement system. To prepare the new LaserTRACER-NG for this challenging environment, it is equipped with a closed housing, just two connectors and a more flexible cable.

Moreover, the LaserTRACER-NG is 40% smaller, weighs less and offers a larger angular range. Thus, it facilitates the measurement in limited machine space. It can also deal with highly dynamic machine movements: the machine accelerations that are allowed during measurement have nearly doubled.

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