

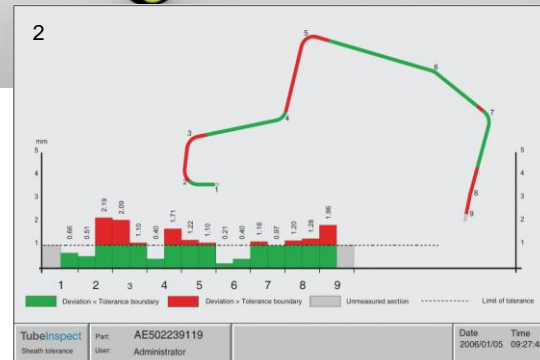
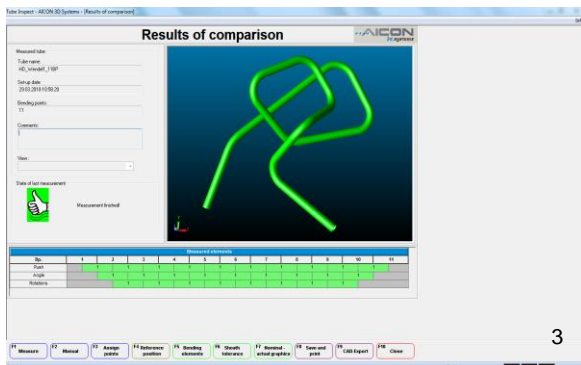
GAUGELESS TESTING OF BRAKE LINES

PRODUCT SPECIFIC GAUGES

are a thing of the past. The new trend is 'gaugeless production', also in the bending unit of tubing production.

The renunciation of physical gauging devices is not surprising, because their procurement and maintenance are a major factor in production costs. This holds in particular for every technical modification and change of models. A re-engineering of mechanical gauges is generally not possible or at least extremely cost-intensive. Universally deployable inspection systems, on the other hand, amortize quickly because they allow the tubing to be immediately gauged. Moreover any assessment of tubing quality with the help of a gauge is a very subjective matter: already the 'personal disposition' of the tester can be decisive as to whether the tube is classified as a good or a bad part.

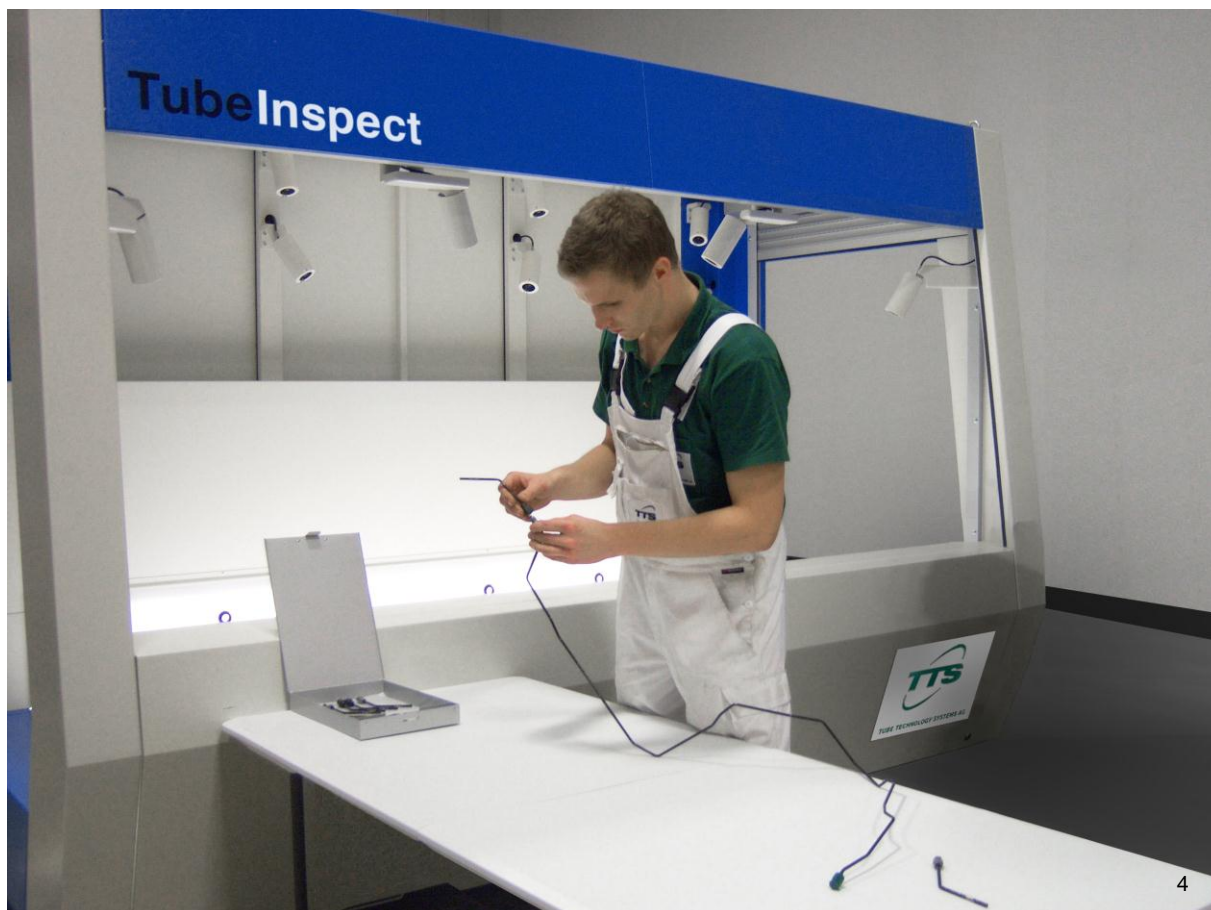
This assessment is also shared by Dr. Andreas Röher, Technical Director of Tube Technology Systems AG



(TTS) from Mas-sen/Germany. TTS has been manufacturing PA-sheathed steel pipes for further machining into

brake lines already since 2004. With a staff of 65 at that time, the company made a name for itself with the patent of a special bolting system for installing brake lines in the vehicle's designed space. Till then, steel pipes already equipped with fittings were sent for machining directly to the car manufacturer bending centers or to tube bending companies and ultimately, following the bending process, on to car manufacturers for final assembly. TTS was able to observe that tube benders customarily tested the dimensional accuracy of the remodeled tubes by means of mechanical gauges. Several gauges were generally needed per vehicle type. Their production was time-consuming and commensurately cost-intensive. The bended tube was placed for testing in the measuring device and adjudged visually as good or bad.

In addition there was no auxiliary device which could accelerate setup of the bending machine. To a certain extent, usability could only be tested on the finished car body. Changeover to a new tubing, i.e., correct adjustment of the bending angle, push and rotation angle



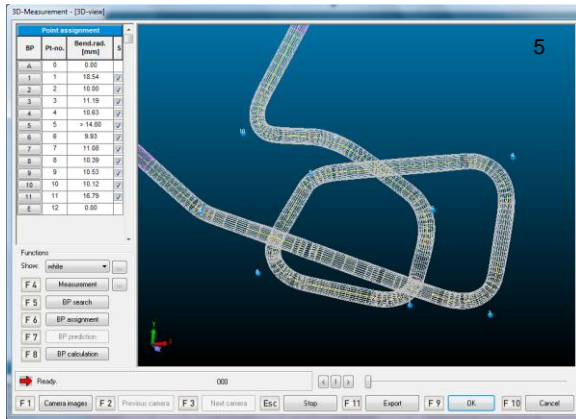
indeed occupied some hours and was extremely dependent on the capabilities of the employee at the bending machine.

In the course of a company reorientation, and after careful deliberation, TTS AG decided also to add the bending process to its own portfolio in excess of pure tube manufacturing. Recognizing a high potential for improvement, an innovative business concept was subsequently worked out: The TTS concept, which is based on optical measuring systems, renders gauges superfluous and thereby substantially reduces production costs. As car manufacturers themselves customarily bear the costs of measuring devices, the TTS concept offered a clear competitive advantage compared to long-established suppliers with conventional gauge technology.

At the same time Dr. Röher already had the appropriate optical measuring device in mind: the system TubeInspect made by AICON 3D Systems GmbH, Braunschweig, which checks tube geometries and transmits comparison values directly to the linked bending machines. And sure enough, TTS AG quickly received positive feedback from its customers. Dr. Röher explains as follows: »The concept was convincing for car manufacturers. No need to have to procure gauges anymore – business-wise that was naturally extremely interesting for our customers« But it wasn't commercial arguments alone that satisfied the car manufacturers. With the process capability of the overall concept, TTS was also persuasive technologi-

cally. The complete manufacturing chain was examined by the car manufacturers – from the production of shell construction lines, to the bending process with Dengler bending machines, all the way to quality controls by means of optical tests. In line with the concept, two bending centers subsequently launched operations: the first in 2009 in Europe and the second in 2010 in the USA. Brake lines here are bended in the immediate vicinity of the car assembly plants, measured by means of TubeInspect and delivered within a narrow time frame thanks to the short transport routes.

A further advantage of TubeInspect is the saving of cost-intensive and generally time-consuming coordinate measuring technology for samplings. Optical testing allows the coordinates of the bending points to be determined within seconds. The TubeInspect measuring system is specially designed for geometrically measuring remodeled tubes and wires and can be deployed in reverse-engineering as well as in prototype construction or series production. In addition, the system determines within seconds the setup and correction data times for the bending machines. Corrections can be transmitted immediately by TCP/IP to the tube bending machine, thereby eliminating time-consuming setup times. In this way TubeInspect replaces a number of conventional mechanical gauges. The measuring procedure is extremely simple. The line to be measured is placed in the measuring cell, the process started, and within seconds the results are visible onscreen: good or bad. The measuring cell is



available in two different sizes depending on the dimensions of the line spectrum to be measured. TubeInspect has a measuring range of 2500 mm x 1100 mm x 700 mm, is suitable for tubes with diameters of 3.2 to 200 mm and registers bend angles of 1 to 180 degrees. The tubes to be measured are simultaneously acquired by 16 digital cameras whereby a slight post reverberation of longer tube sections has no effect on measurement accuracy. By virtue of the large measurement volume even long and complex tubing is easily measurable. By means of reference points the software determines the precise position of the cameras. TubeInspect S has a measurement volume of 1100 mm x 1100 mm x 700 mm and is equipped with 10 cameras. The scope of functions is completely identical with that of the larger model. Both systems are thus also able to measure complicated tube runs like bend in bend. TubeInspect is likewise designed for an automated 100% control: a robot removes the bended part from the bending machine and holds it in the measuring cell. The measuring process starts automatically. The finished tube can immediately be graded as a good or bad part.

With AICON's purely optical measuring system, TTS AG has successfully positioned itself among the previous players in the car manufacturer supplier segment.

For Dr. Röher 'the time was simply ripe for gaugeless production'. TTS still has some plans for the future, says Dr. Röher. More sites for gaugeless production are to be launched. With a concept of this caliber, it is easily quite conceivable.

Images:

1. Measurement results are visible onscreen within seconds, gauge change is done by menu selection.
2. Even long and thin tubes can be measured without fixtures.
3. Graphical output of tolerance errors
4. Measurement with TubeInspect
5. The TubeInspect calculates a 3D cylinder model of the tube and compares actual against nominal data.
- 6 Dr. Röher in a discussion with grad. engineer Klaus Daenicke, After Sales team leader

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