VISCOM
vision technology

Case Study

3D-AOI 3D-AXI 3D-SPI 3D-MXI

WABCO

The Latest Transmission Controls for Utility Vehicles— Inspected with 3D SPI and 3D AOI from Viscom

Lead process engineer Rüdiger Borges, process technician Andreas Sommerfeld and test methodologist Lars Schulze next to the S3088 SPI from Viscom

Integrated Solution with Data Networking

Today's ABS braking systems, manual transmissions and many other vehicle components represent ever more complex solutions. This in turn means greater and greater demands on quality testing. WABCO develops and produces the latest in automotive electronics in Hanover, Germany, which later reliably perform their duties in trucks and buses from well-known manufacturers. Thanks to an integrated solution with 3D SPI, 3D AOI and data networking via the Viscom Quality Uplink, the company has very successfully optimized its production quality in close collaboration with Viscom AG.

The firm Westinghouse Air Brake Company (WABCO) looks back on a long history in the United States, yet today is headquartered in the Belgian capital of Brussels. Its locations are distributed from the USA to Australia, India and Japan, as well as many other countries including Germany. At Lindener Hafen in Hanover, the WABCO electronics manufacturing runs virtually around the clock.

As part of an ongoing development partnership since 2014, a prototype line with the systems S3088 SPI and S3088 *ultra* from Viscom has taken shape in stages here. A team from WABCO, working in close contact with select Viscom experts, gave different inspection methods from 2D through 2.5D and 3D a close examination under production conditions to find out which of these approaches could be applied most effectively for which inspection criteria. The goal was the right combination for positive detection of real defects. As a result, the false call rate could be consistently decreased and First Pass Yield significantly increased.

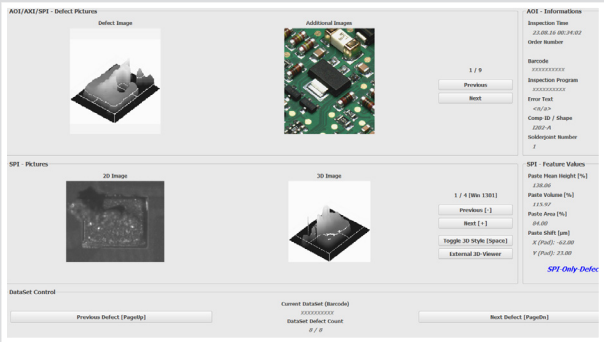
Electronics and mechanics under one roof

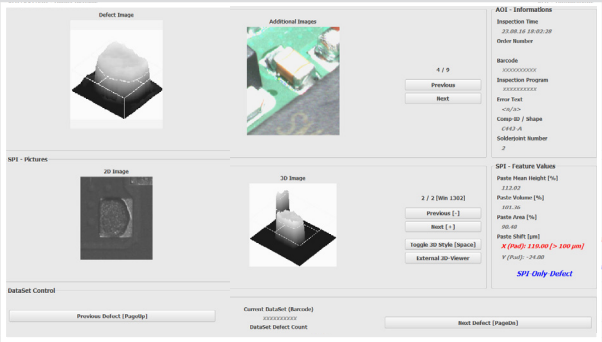
Among its other products, WABCO is known for its ABS systems. "Electronic braking systems, transmission controls, air suspension systems and the associated peripherals, like compressors and air dryers—these are the electronic items our customers seek from us. The brake area includes disk brakes in addition to conventional drum brake systems," states Lars Schulze, test methodologist at WABCO. He supervises the automatic optical inspection (AOI) in the electronics manufacturing and configures the requisite inspection programs. "The electronic systems, of course, must be coupled with the mechanics; we also do this in the factory. That means, we manufacture the electronics here and deliver them to the adjacent hall, where the respective mechanics are assembled," explains Schulze. The keyword is "mechatronics".

Hanover is the main electronics development center for WABCO. Another similarly equipped subsidiary is located in Wrocław, in bordering Poland. All other production locations focus primarily on manufacturing the mechanics. In the Lower Saxony regional capital Hanover, WABCO engages around 2,600 employees, with about 250 of them in electronics production. Customers include DAF Trucks, Daimler, MAN, Scania and Volvo, as well as ZF Friedrichshafen.

Space for electronic components occupied up to 95 percent

One very important product at WABCO right now is a highly complex printed circuit board with around 450 components, to be used in utility vehicles as the core of the transmission control. Rüdiger Borges, lead process engineer at WABCO, comments: "We introduced this transmission





Among other things, the Viscom Uplink Process Analyzer (VUPA) enables the comparison between SPI data and AOI images

electronics unit in 2015; the space on these printed circuit boards available for electronic components is occupied at up to 95 percent. This is atypical in comparison to normal electronics manufacturing, where space requirements could be about 70 to 80 percent." Especially for this product, with its extremely high packaging density where sometimes not even the inspection system's angled camera reveals much of value, the 3D analysis is a great help.

Everything is closely packed side by side, which is one good reason WABCO deploys the 3D AOI system S3088 *ultra* from Viscom in its prototype line. According to Borges, development increasingly leads toward smaller component types such as the QFN, on which the connections are no longer visible at all or with angled cameras, are visible only to a limited degree.

3D SPI with convincing possibilities for data networking

One of WABCO´s goals for the solder paste inspection (SPI) line was to enable the employee to fulfill multiple tasks. This was very successfully realized in the prototype line with an S3088 SPI from Viscom. This paste inspection system was not the first WABCO had acquired for its production. However, as a new investment became necessary, because of the data variety and configurations, the system was able to prove itself in a benchmark comparison. Especially convincing were the system capabilities for highly automated data networking via the Quality Uplink and the verification station HARAN from Viscom. Rüdiger Borges explains, "We said, we want to go in this direction, and took a very close look." WABCO's goal was to not only be able to assess the process as a whole, but also in all its individual steps. For example, the assembly and oven processes have their own process-relevant characteristics.

The employees at WABCO wanted to know with as much detail as possible when a defective printed circuit board actually needed to be taken out of the production line, for example, right after the printer because the SPI system indicates the paste is smeared or there is no paste at all. In these cases, assembling with components would be superfluous. This is especially worthwhile at WABCO, where certain products are not permitted to be repaired and there is no other option than to scrap them. If defective printed circuit boards are not needlessly assembled with components, costs and materials are saved. The earlier they can be sorted out, the better. This is where the S3088 SPI from Viscom makes a substantial contribution. That this is a modern 3D system also has its advantages. "If the paste is looked at from above, only a surface is seen. But I never know, is this paste volume also high enough and is it sufficient to definitively reach the minimum volume? This is better perceived with a 3D inspection than with a 2D," explains Andreas Sommerfeld, process technician at WABCO. His primary responsibility is the SPI system with its Viscom Quality Uplink functions and the associated program creation and optimization.

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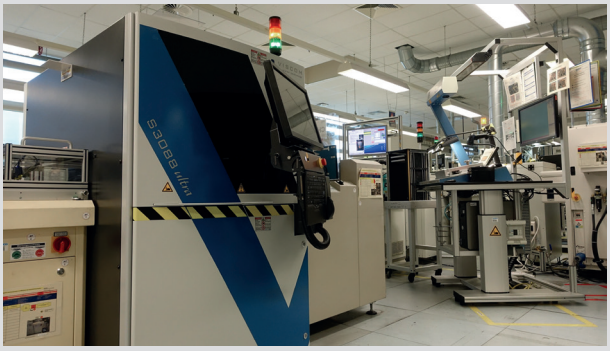

S3088 *ultra* and in the background, the verification station HARAN from Viscom

Machines communicate with each other

Compared to what it was earlier, the amount of image information that the SPI system transfers to the AOI process in the prototype line is enormous and is managed with a gigabit LAN. "The moment the employee scans the electronic assembly at the verification station after the AOI, the data must be available immediately," explains Sommerfeld. One very useful function of the Quality Uplink is that as soon as the SPI system determines a defect, the AOI system receives the instruction to take 360 degree color image acquisitions from nine perspectives with its high resolution cameras. This makes it relatively easy to discern that solder bridges WABCO has detected during the solder paste or automatic optical inspection as a typical paste defect cannot be traced back to faulty parameter settings on the SPI or AOI system, or the stencil printer. The causes for the existence of most solder bridges can be markedly reduced by improved printed circuit board design, or by improved cleaning of the printed circuit boards in the delivery state.

The Closed Loop from Viscom is also part of the Quality Uplink. This is based primarily on the communication between the solder paste inspection and the upstream stencil printer; for example, the SPI system cyclically determines and transfers specific values to the printing process. "This way, the X/Y offset can be automatically corrected," says Sommerfeld. Consequently, he and his colleagues can greatly extend the printer cleaning cycle. Whereas only five or even fewer print cycles before cleaning used to be the norm, in one test run with the Closed Loop function, the printer first needed re-cleaning after 20 cycles. This saves both time and material.

Individual solutions on request

One example for an improved understanding of the process in detail is the paste deposit for Ball Grid Arrays (BGAs). Here it was possible for the WABCO employees to classify a tolerance limit of at least 25 percent of the actual setpoint as fully adequate. "We have determined that because of the pre-tinning of the BGAs, it is actually only important that they come in contact with the paste. As long as this is approximately the case, there are no other problems when the soldering process is in a steady state," claims Borges. The Viscom Quality Uplink also serves well if anything suspect regarding process limits does nonetheless emerge during solder paste inspection. A marking ensures that the inspected printed circuit boards or electronic assemblies inspected are routed by the AOI system for an additional manual X-ray inspection, even though no defect has in fact been detected. Previously, employees had to affix a point on the carrier outside the solder area. At WABCO's request, this step has now been automated by the developers at Viscom. That this printed circuit board must be X-rayed is also visible to the operator at the verification station HARAN through a corresponding display.

Viscom had earlier realized other individual requests from WABCO, such as enabling a relatively quick removal of defective printed circuit boards from the S3088 SPI by just opening the hood. Previously, the machine had to be shut down and started up again. Or a downstream buffer module had to be dealt with, bringing additional costs. Another example of an individual solution by Viscom is the new possibility to manually enter barcodes on the SPI system.

Tests guarantee long service life

At the WABCO location in Hanover, the long-term stability of electronic

Planned Engineering Innovation Center at WABCO in Hanover

assemblies is also tested. If, for example, 50 percent of the paste is missing on a resistor, it is not evident to the eye because everything is cleanly soldered. But it is unlikely these printed circuit boards would ever withstand the load test through which WABCO checks mechanical resiliency for a desired service life of from ten to 15 years. In this test, the electronics must be able to endure temperature fluctuations from -40 °C to +150 °C because, for example, they are installed tightly within a transmission.

Rüdiger Borges explains: "As compared to the passenger automobile, our products are in service significantly longer. In the after-sales market, some units run for 15 to 20 years. And there are always those electronics we have to reinstall. This is nothing out of the ordinary and in principle, is a reality that also sets a certain standard for us; on the one hand, to develop highly modern electronics, at the latest level, with the most up-to-date technologies, but on the other to continue producing the existing electronics."

Internal processes according to Six Sigma + Lean

Here the coexistence of the proven and the novel at WABCO is a matter of course. The worldwide transport of goods and use of public transportation means are both trends with a very promising future potential. Rising demands on safety and environmental aspects are essential challenges. As a supplier of intelligent solutions for the utility vehicle industry, WABCO is right in the middle of these exciting developments. An intelligently networked inspection of the electronic products is an integral component in these developments. The WABCO quality goals are grounded in the "Six Sigma + Lean" philosophy. Specially trained internal employees actively ensure these goals are met. "This is why we also have our training center here in Hanover, which is officially open to other companies as well," according to Borges. Six Sigma + Lean is strictly integrated into practice at WABCO; correspondingly, defect detection and process optimization are addressed as an indispensable aspect of this focus. Sustainable handling of resources also plays a very important role here.

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Greatly improved process with 3D AOI

When working with the S3088 *ultra* it is also important that the employee can quickly notice a serial defect, whether it be incorrect rotation or a displaced component, and immediately react correctly. WABCO leased the AOI system in 2014 and as a condition for an optional purchase, stipulated that a First Pass Yield (FPY) of at least 80 percent referenced to the electronic assemblies would be reached by 2016. The 3D analysis of the S3088 *ultra* ensures fast, dependable results in detecting component fluctuations, coplanarity or other defects. Numerous inspection patterns were fundamentally streamlined because unwieldy linked analysis steps could be omitted. Component body detection is greatly improved by the 3D analysis, so lifted leads and other defects are easier to find. "For the presence inspection, no special

cameras or adapted illumination are needed; neither are fine adjustments for the different components or printed circuit board colors. With the 3D raster, whether or not the component is there is immediately apparent," as Lars Schulze describes the possibilities. Among other aspects of the S3088 *ultra*, he tested the 3D options and adapted them to WABCO requirements. His primary responsibilities include statistical evaluation with the Viscom Uplink Process Analyzer (VUPA) and the SPC (statistical process control) function of the Quality Uplink. "The inspection used to be a subjective evaluation which could never encompass the entire printed circuit board. Now we have direct measurements, can record defect concentrations and statistically calculate stability. As one example, analysis of the last 50 printed circuit boards instantly informs the operator where tolerance ranges have been exceeded; changes in the process can be made based on these indexes," says Schulze.

With the 80 % FPY long since reached, now only every fifth electronic assembly needs to be rechecked at the verification station. Even 90 percent FPY has become a norm rather than an exception. Just as with the SPI inspection stage, now the employee who formerly stood at an AOI system is primarily occupied with the ICT (in-circuit test) system. Meanwhile, WABCO has purchased the S3088 *ultra* by Viscom. Both companies still maintain a strong interest in fast, efficient implementation of good ideas into practice. From planning to deployment, up to optimization and ongoing development, exciting synergy effects are certain to arise from the continuing partnership between WABCO and Viscom in the future. This is one genuine win-win situation.

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